THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*Researches on the Radiations of Incandescent Bodies, and on the Elementary Colors of the Solar Spectrum;* by M. MELLONI.*

AMONG the more recent scientific publications will be found a Memoir by the American Professor, J. W. Draper, "*on the production of Light by Heat,*"† which appears to me to merit the attentive consideration of those who interest themselves in the progress of the natural sciences. The author treats, in a very ingenious manner, some questions allied to my own researches on light and radiant heat. In reading this interesting work, several ideas have presented themselves to me, which I have submitted to the test of experiment. I believe that an analysis of the memoir of Mr. Draper, accompanied with a brief account of what I have done, will not be without interest to the readers of this Journal.

Every one knows that heat, when it accumulates in bodies, at last renders them *incandescent;* that is to say, more or less luminous and visible in the dark. Is the temperature necessary to produce this state of incandescence always the same, or does it vary with the nature of the body? In either case what is its degree? and what is the succession of colored lights, emitted by a given substance, when brought to temperatures more and more elevated? Finally, what is the relation that subsists at different periods of incandescence between the temperature and the quantity of light and of heat emitted by a body?

* Read at the Royal Academy of Sciences at Naples, July 6th, 1847, and translated from the Bibliotheque Universelle of Geneva, for August, 1847.

† Philosophical Magazine, May, 1847, vol. xx, p. 345. Also this Journal, vol. iv, ii Ser., p. 388.

To solve these different questions, of which some have been already studied by other philosophers, Professor Draper has made use of an instrument composed of a strip of platina ignited by the action of a voltaic current. The strip was vertical, its length one inch and one-third, its width the twentieth of an inch, and its upper extremity being fastened to a firm support, it was kept stretched by a little weight furnished with a copper wire, that dipped into some mercury placed in a cup below. The electric circuit was established by placing the mercury and the upper extremity of the platina strip in communication with the poles of a Grove's battery, of which the force, properly moderated by a Wheatstone's rheostat, could be kept constant for about an hour. By means of this arrangement, the strip of platina, more or less ignited by the action of the voltaic current, preserved its rectilinear direction; the copper wire which was fastened to the weight merely dipping more or less deeply into the mercury. To determine the dilatations of the strip, there was attached to its free extremity a long and very slender horizontal lever, arranged in such a manner that the point of attachment was very near one of the extremities of the lever which worked upon a pivot, and the other end traversed over a divided scale, taking a position more or less oblique to the horizon as the weight and wire descended by the dilatation of the strip, and indicating on the graduated arc the quantities sought.

The temperatures were then calculated on the hypothesis that they were proportional to the dilatation of the platinum; employing for this purpose the coefficient of Dulong and Petit. It will be understood that these calculations are easily made when we know the length of the strip and of the lever, and also the position of their point of attachment. In the instrument employed by Draper, each degree on the graduated arc corresponded to an elevation of 115° F. above the temperature of the air.

Suppose, now, we commence by using a feeble current, the force of which is gradually increased by means of the rheostat. The heat correspondingly augments in the strip, and finally makes it visibly red hot in the dark room in which the experiment is to be conducted. The degree that the index marks is then to be observed. This experiment was repeated several times, and with the aid of different persons, (who ought to remain for some time in the dark for their eyes to acquire a due sensibility,) and from the mean of all the observations the temperature at which the platina began to be red hot was calculated. From the experiments of our author this temperature is 977° F.

To determine whether all substances become red hot at the same degree of heat, Professor Draper took a gun-barrel, the touch hole of which was closed, and placed in it successively platina, copper, gas carbon, lead, earthenware, and other substan-

ces; then, making the barrel red hot in the fire, he observed attentively the moment when the incandescence commenced to manifest itself in the barrel, and the substance which it contained. He could discover no difference of time between the two phenomena, for the gun-barrel and the substance under trial became simultaneously luminous as the temperature was rising, and also simultaneously lost this property when, after being removed from the fire, and carried into a dark place the temperature fell by radiation.

It is important to observe, that in some cases, for example with lead, the matter contained in the tube became incandescent some time after it had melted; this shews that the temperature necessary for the first manifestation of the luminous condition does not depend on the *solid* state of the body submitted to the experiment, and that it takes place in all substances which maintain themselves in the liquid condition without boiling at 977° F. Professor Draper excepts from this law the fluorid of calcium and carbonate of lime which become luminous much sooner. These cases do not in reality belong to the phenomena we are now considering, but to those of *phosphorescence*, which require a lower degree of heat, according to the nature of the substance. I may add, that regarding the question in a general point of view, we should also except those cases in which the development of light arises in chemical combinations.

But these two exceptions are easily recognized by the quality of the first colors that appear. Thus the carbonate of lime emits the moment it becomes visible, a white light; and the fluorid of calcium a blue light. Sulphur appears yellow when it combines chemically with copper, and blue when it unites with oxygen. Some philosophers of the highest eminence, among others M. Biot, suppose that the first light disengaged by incandescent bodies is of the latter color; and they have accounted for this on the principles of a theory which is now almost universally abandoned.* We shall presently see what is the probable origin of the various tints that arise from phosphorescent bodies and chemical combinations; we shall merely observe here, that the color mentioned by Biot occurs in flames; and, that these cases of combustion, belonging to the class of chemical combinations, ought to be carefully distinguished from incandescence properly speaking, which arises directly and solely, as we have already said, from an elevation of temperature in the body, and which always commences with a red light.

As to the exact degree of this temperature, the objections which might be raised against the mode employed by our author are of very little importance; if we compare the results at which he ar-

* Biot; Traité de Physique, vol. iv, p. 617.

rives with those that have been obtained by Wedgewood and Daniell, the difference is only 30° in excess for the first case, and 3° too little in the second. The differences are much greater when compared with the deductions of Davy and Newton, which give 812° and 635°. But those numbers, and especially the latter, were obtained by methods too imperfect to be trustworthy. Consequently, the number 977° F. given by our author, must approach very closely the degree of heat which produces the first incandescence of bodies.

After having studied this first question, already examined by other philosophers, Professor Draper enters on an entirely new field of research, investigating the nature of the colors which are developed by an ignited body as its temperature is increased.

For this purpose he employed a prism of fine flint glass, setting it vertically at a certain distance from the strip of platina; but, previously, having placed in the position the platina was to occupy, a vertical slit of the same size in a piece of metal, through which a beam of the daylight passed. The spectrum resulting from the transmission of this beam through the prism was received on a small telescope furnished with micrometric wires, and carefully examined in its different parts, for the purpose of determining exactly the position of Fraunhofer's dark lines. The strip of platina was then set in the same place, and he proceeded to make observations on the spectra produced by it at different periods of incandescence. From these it results that the first spectrum visible in complete darkness corresponds to a temperature of 1210° F. and extends from the fixed line B to the line F. The second spectrum produced by a temperature of 1325° commences very nearly at the same line B, and terminates at the line *d*; the third at a temperature of 1440°, appears to begin a little nearer the line A, and goes to some distance beyond G; lastly, the fourth, corresponding to a temperature of 2130°, approaches much nearer to A, and extends as far as the line *l*. In other words, the spectrum of the strip of platina which corresponds to the red extremity of the prismatic spectrum, is at first very short, and contains only the less refrangible colors; but as the temperature rises, the spectrum of incandescence extends towards the violet extremity, obtaining the more refrangible tints, and at last acquiring all the colors and all the extent of the solar spectrum, except the terminal rays at the two extremities, which escape the observer evidently on account of their extreme feebleness. The same cause (insensibility due to a want of luminous energy) makes the first spectrum appear, at the red end, a little shorter than the last; because the less refrangible rays of that color are, as is well known, so feeble, even in the solar spectrum, that we are unable to perceive them unless they are isolated in a place that is totally dark. Much more, therefore, ought they to remain invisible to the ob-

server when the spectrum arises from luminous agencies so little energetic as are those of the first periods of incandescence.

To a perfectly sensitive eye the variations of length would evidently have taken place in the direction of the more refrangible rays only; and all the spectra would have commenced at the extreme limit of the red rays.

It results from all these observations, that when the incandescence of a body becomes more and more vivid and brilliant by the elevation of its temperature, there is not only an augmentation in the intensity of the resulting light, but also in the variety of elementary colors which compose it; there is too an addition of rays so much the more refrangible as the temperature of the incandescent body is higher. In this there is therefore established an intimate analogy between the progressive development of light and that of heat. Indeed, as soon as I had convinced myself of the immediate transmission of every variety of radiant heat through rock salt, I availed myself of that valuable property to study the refraction of heat from different sources; and I discovered that radiations coming from those of a high temperature contain elements more refrangible than those which are derived from sources that are not so hot.

After having pointed out how very important for the theory of the identity of calorific and luminous radiations is the analogy or rather absolute equality which exists between his experiments and mine on the successive appearance of the elementary rays, Professor Draper passes forward to investigate the law of the increase of the luminous and calorific radiations, according as the temperature of the source of heat is elevated.

Bouguer has shewn, that a difference of $\frac{1}{60}$ in the quantity of light which acts on the eye is insensible; and that thus this fraction constitutes the limit of perceptible variations. From this it arises that we easily perceive differences in the intensity of light when they exceed even to the smallest extent the sixtieth part of the entire quantity. Let there be placed, for example, an opaque cylinder between the red hot platina, or other source of light, and a sheet of white paper arranged at such a distance that its surface may be illuminated all over by the light of the shining body, except on those parts where the shadow of the cylinder is thrown. Then let there be a lamp furnished with a metallic tube, in which there is a small opening; let the rays of the lamp which go out through the aperture fall on the paper enlightened by the luminous source of which we wish to measure the intensity; let the lamp be gradually approached until the shadow of the cylinder is no longer sensible; let this experiment be repeated in each of the different cases we wish to compare with one another, measuring each time the distance from the lamp to the paper. It is then evident that the values sought will be in the inverse ratio of the numbers found.

This method, invented by Bouguer, to determine the relative intensities of different luminous sources, and employed by Draper to measure the quantities of light emitted by a strip of platina brought to different degrees of incandescence, is the only one by which we could hope for a successful result. The method of the equality of shadows, well known under the name of Rumford's method, would have furnished in the researches of the learned American uncertain data, on account of the difficulty of establishing an exact comparison between the *accidental green tint* introduced into the shadow enlightened by the yellow rays of the lamp, and the red light emitted by the ignited metal.

As to the measures of the radiant heat, they were determined by the aid of the thermo-multiplier; that admirable instrument which has revealed to science so many new properties of calorific radiations, and which still is rendering eminent services in the hands of able chemists far beyond the Alps. Professor Draper had only to arrange at a certain distance from his strip of platina a thermo-electric pile, and to observe for each phase of incandescence the deviation of the index of the galvanometer, to determine the quantities sought. In this manner he obtained the numbers contained in the following table, divided into three columns. The first of these columns indicates the temperature for each degree of the scale of dilatation, commencing with the point of incandescence. The difference between each of the successive terms of this series is thus constant, and equal to 115°. The second and third columns give the corresponding quantities of light and heat. It is almost superfluous to add that the unity for light is entirely independent of that for heat; and that the similar independent unities are not referrible to the same point of the scale.

Temperature of the platinum.	Intensity of light.	Intensity of heat.
980	. . .	·87
1095	. . .	1·10
1210	. . .	1·50
1325	. . .	1·80
1440	. . .	2·20
1555	. . .	2·80
1670	. . .	3·70
1785	. . .	5·00
1900	0·34	6·80
2015	0·62	8·60
2130	1·73	10·00
2245	2·92	12·50
2360	4·40	15·50
2475	7·24	. . . .
2590	12·34	. . . .

The numbers of the two latter columns shew evidently that the augmentations of both these agents, though feeble at first, become very rapid at last; from which it results that the radiations both of light and heat, follow in the *progression of quantity* the same analogy that we have just observed in the *progression of quality*.

This parallel march of the two agents seems to have entirely changed the opinion of the author as to the nature of the rays of light and heat, and the different chemical and physiological effects due to the sun and terrestrial luminous and calorific sources. The preamble of his memoir contains the following passage relative to this point:

"As the experiments now to be described lead to some striking and perhaps unexpected analogies between light and heat, they commend themselves to our attention, as having a bearing on the question of the identity of those imponderable principles. It is known that heretofore I have been led to believe in the existence of cardinal distinctions, not only between these but also other imponderable agents; and I may therefore state, that when this investigation was first undertaken, it was in the expectation that it would lead to results very different from those that have actually arisen."

The author adds, immediately after the experiments relative to the luminous and calorific radiations, which are simultaneously developed in the strip of platina at different phases of incandescence, "I cannot here express myself with too much emphasis on the remarkable analogy between light and heat which these experiments reveal. The march of the phenomena, in all their leading points, is the same in both cases. The rapid increase of effect as the temperature rises is common to both. And it is not to be forgotten, that, in the case of light, we necessarily measure its effects by an apparatus which possesses special peculiarities. The eye is insensible to rays which are not comprehended within certain limits of refrangibility. In these experiments, it is requisite to raise the temperature of the platinum almost to 1000° before we can discover the first traces of light. Measures obtained under such circumstances are dependent on the physiological action of the visual organ itself, and hence their analogy with those obtained by the thermometer becomes more striking, because we should scarcely have anticipated that it could be so complete."

After the second series of experiments, relative to the quality of the rays emitted as the temperature of the metal rises, Professor Draper criticises some of the facts upon which Sir D. Brewster founds his opinion on the existence of the red, yellow and blue colors in every part of the Newtonian spectrum. These criticisms acquire more importance since the illustrious mathematician, Airy, the Astronomer Royal of England, has denied the deductions of Sir D. Brewster, and refers to several of his experimental researches in support of the view, that a particular color corresponds to each element of the spectrum.*

* Philosophical Magazine, No. 199, Feb., 1847.—(*Note of the author.*) Sir D. Brewster has inserted in the number for March, 1847, of the same Journal, a refutation of the criticisms of Mr. Airy. We regret that we are at present unable to present an extract of it.—(*Note of M. de la R.*)

"As (in the experiment in which a metal is ignited)," adds Professor Draper, "the luminous effects are undoubtedly owing to a vibratory movement executed by the molecules of the platinum, it seems from the foregoing considerations to follow, that the frequency of those vibrations increases with the temperature.* In this observation I am led by the principle, that 'to a particular color there ever belongs a particular wave-length, and to a particular wave-length there ever belongs a particular color;' but in the analysis of the spectrum made by Sir D. Brewster by the aid of absorptive media, this principle is indirectly controverted; that eminent philosopher shewing that red, yellow, blue, and consequently white light, exist in every part of the spectrum. This must necessarily take place when a prism which has a refracting face of considerable magnitude is used; for it is obvious that a ray falling near the edge, and one falling near the back, after dispersion, will paint these several spectra on the screen; the colors of the one not coinciding with, but overlapping the colors of the other. In such a spectrum there must undoubtedly be a general commixture of the rays; but may we not fairly enquire whether, if an elementary prism were used, the same facts would hold good; or, if the anterior face of the prism were covered by a screen, so as to expose a narrow fissure parallel to the axis of the instrument, would there be found in the spectrum it gave every color in every part, as in Sir D. Brewster's original experiment? M. Melloni has shewn how this very consideration complicates the phenomena of radiant heat; and it would seem a very plausible suggestion that the effect here pointed out must occur in an analogous manner for the phenomena of light."†

I shall here observe frankly, that the optical complication (alluded to in this criticism) does take place, as may be clearly proved; it is this very circumstance which led me to detect the errors which had been committed in the determination of the maximum of temperature in spectra arising from different substances. That

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* This expression ought not to be taken in an absolute sense, but rather as relative to the new rays which at a given temperature are added to those already existing in the spectrum.—(*Note of M. Melloni.*)

† Sir David Brewster has replied to Professor Draper as follows:—"As my experiments were not made upon spectra formed upon screens by prisms with large refracting surfaces, they are not liable to this criticism, even if it were otherwise well founded. The spectra which I use are so pure, and free from all commixture, that Fraunhofer's black lines are distinctly visible; and the results are precisely the same when the refracting face of the prism is reduced to the smallest possible dimensions."

"My analysis of the spectrum by absorption, does not therefore *indirectly controvert* the principle, that 'to a particular color there ever belongs a particular wave-length, and to a particular wave-length there ever belongs a particular color,' as Dr. Draper states, in theoretical language, the well known proposition of Sir Isaac Newton; but it *directly controverts it*, and *absolutely overturns* it."—Philos. Mag., June, 1847, p. 462.—(*Note of M. de la R.*)

there may remain no doubt on this point, I will transcribe from my memoir, communicated to the Royal Academy on November 24th, 1843, the part that relates to this subject.

"Let one of the three surfaces of an ordinary glass prism be covered with a layer of India ink; let it dry, and then divide it into three equal portions at right angles to its axis. Remove with a penknife the ink from the middle portion, and also a band four or five millimetres wide on the sides of the two lateral compartments, so that these two bands from which the ink has been removed, may be on opposite sides, and form by their junction with the central force a kind of Z. It will be understood, that a solar beam issuing from a prism thus arranged will produce three colored images side by side; the middle one is very luminous,—it arises from the part of the prism from which all the ink is removed; the two others, which are much paler, arise from the lateral bands. It will also be perceived, that the middle image or spectrum has each of its extremities on the boundary of one of the extremities of the lateral spectra; and that when, for example, its red extremity is in the same line with the red extremity of the left spectrum, its violet extremity will be upon the same line as the violet extremity of the right spectrum, and vice versâ. As to the other two extremities of the lateral spectra, they will not be found corresponding to the extremities of the central spectrum, but to some one of the interior colors, and they will evidently be more distant as the width of the uncovered bands is less in proportion to the width of the prism. In one of my experiments made with an equilateral prism of crown glass, the width of which was twenty-four millimetres, and that of the lateral bands five, I found, at a distance of two metres, that the red extremity of the left spectrum was upon the same line as the upper part of the yellow belonging to the central image, and the violet extremity of the right spectrum was upon the blue of the same image. A prism of water, prepared in like manner, of which the refracting angle was 79°, gave analogous results. In one, as in the other case, the red extremity of the left spectrum was on a level with the green of the central image, when the observations were made at the distance of a metre from the prism.

"Let us imagine the central unpainted part of our prism to be divided into a series of longitudinal elements, the width of each being equal to that of the lateral bands. It is clear, that each of these elements will produce a refracted image similar to the two pale spectra arising from the lateral bands; and that the two last images of the series will be as it were continuations of those spectra. Therefore, the red and the violet which we see by the side of the yellow and blue of the central colored spectrum, equally exist in that central spectrum, and enter into the composition of those tints. This argument is unanswerable; it establishes that

instead of being absolutely pure, or even nearly so, the gradations of the image formed by the central compartment contain different colors."*

I had already proved, in 1843, that the colors obtained by ordinary prisms at a distance less than two metres, are composed of a mixture of colors belonging to the spectra of the different elementary bands of the prism; and that the red, the violet, and consequently all the other prismatic colors of the two extreme elements, are so much the nearer to the centre as the observation is made nearer to the prism. Now, in the experiment of Sir D. Brewster the prism is very close to the eye,—the spectrum obtained in this experiment must necessarily be formed of very impure tints; and the color which appears in a given zone, which has lost by absorption the dominant tint, does not belong to a ray of the same refrangibility as the tint absorbed, but rather to colors of the elementary spectra of the superior or inferior parts of the prism.

To prove this directly, I have repeated the fundamental experiment of Sir D. Brewster. It consists, as is well known, in interposing between the eye and the spectrum, produced by the refracted image of a luminous object seen through the prism, a slip of glass deeply colored blue by the oxyd of cobalt. The spectrum was formed from the light of a circular aperture, ten millimetres in diameter, made in a metallic plate placed in the shutter of a dark chamber. The prism was of flint glass, equilateral, twenty-five millimetres wide, and sufficiently pure to produce distinctly the black lines of Fraunhofer. It was attached to its support by one end, placed fifteen feet from the window, and fixed horizontally in the position of minimum deviation. Its anterior face was covered for one-third of its extent with India ink. From the middle of this there was removed a longitudinal space which ran from end to end of the blackened band, leaving free and uncovered a horizontal line little more than a millimetre in width. The slip of blue glass covered only two-thirds of the prism counting from the painted extremity.

Things being thus arranged, I observed the image of the aperture successively through the uncovered part of the prism, and then through the two portions on which the blue glass was placed. The first operation gave me the normal spectrum; the second, made after the method of Brewster, furnished a complex spectrum; the third, a spectrum arising from a little portion which may be regarded as the mean longitudinal element of the prism. Now, on comparing the first image with the second, I observed the phenomena of luminous and obscure zones so well described by Herschel. On comparing then the third image with the se-

* Museo di Scienze, lettere ed. arti, vol. i, fasc. 1, Napoli dic 1843. *Bibliotheque Univer.*, 1844, vol. xlix, p. 141.

cond, I perceived that the luminous zones belonging to the *elementary spectrum* were much more sharp, although less intense, *much narrower*, and traversed by obscure zones, much deeper, larger, and with contours more striking than those of the spectrum which came from the unpainted part of the prism. It was easy thus to convince myself, by the comparative inspection of the three images, that the differences of tint between the second and third spectrum corresponded to the colors which Sir D. Brewster imagines to have the same refrangibility as the tints absorbed. In his spectrum, for instance, the normal orange color is replaced by an obscure zone invaded on one side by the red, and on the other by the yellow, from which he infers the presence of these two colors in the orange. Now these invasions of the yellow and red do not exist in my elementary spectrum. *in which all the space corresponding to the orange is occupied by a dark zone; the red and the yellow which limit this zone, in the spectrum produced by all the middle part of the prism covered by the blue glass, are therefore independent of this spectrum, and belong to spectra of elementary layers superior and inferior to the intermediate line.*

This last conclusion is nevertheless not exempt from objections. For in a dark room the observer must necessarily have his pupil much dilated, and his sight be more or less confused; consequently, on looking at one time through the uncovered prism, and at another through a limited space of the prism narrower than the pupil of the eye, it may happen that the greater extent of the tints transmitted by the blue glass in the first observation may arise from an indistinct vision, and not from a real overlapping of the colors from the superior and inferior parts of the prism. This conjecture seems the more plausible since all the rays refracted by the prismatic elements, are not perceived by the observer, but only those that pass through the aperture of the pupil.

To determine whether this was, in reality, the cause of the phenomenon, I placed four small bands of tin around the circular hole in the shutter, and arranged them so that they formed by crossing one another a perfectly square aperture, the sides of which were horizontal and vertical. Then placing before the prism a slip of glass of a deeper blue than the preceeding, I saw on looking successively through the central part of the prism and the part from which the paint was partially removed, that the two spectra modified by the interposition of the colored medium were composed of a red rectangle, almost square, followed by a broad dark zone, and then by a very brilliant yellow rectangle of which the longer sides were directed vertically and parallel to the length of the spectrum. There came then a deep indistinct color, then the blue, to the modifications of which it is unnecessary here to attend, but only to the changes of color and darkness of the space already mentioned which precedes the yellow.

On observing attentively the rectangular form of the space occupied by the yellow rays in each of these spectra, it will be distinctly perceived to be less elongated in the *elementary spectrum* than in the *compound spectrum.* Now distinct vision may diminish the magnitude of the image formed upon the retina, and render the contours more decided and sharp, but it cannot vary the relations of its dimensions. The shorter length of the yellow rectangle in the elementary spectrum must then arise from an effect different from that which is produced on vision by the smallness of the aperture through which the prismatic image is observed. We cannot, therefore, suppose, the vertical sides of the rectangle being a little sharper and more vivid than the horizontal ones, that this difference of illumination can give origin to the phenomenon in question;—for any alteration arising in that way would be in the opposite direction to that actually observed. For, in reality, the most luminous images being those which undergo the greater reduction of size in passing from confused to distinct vision, the yellow rectangle of the spectrum observed in the elementary prism ought to be shorter in the horizontal than in the vertical direction; nevertheless, the difference is manifested in just the opposite manner. Therefore, the elongation of the yellow rectangle in the central spectrum arises beyond all doubt, altogether or in part, from a partial overlapping of the yellow rays belonging to the spectra of the entire series of elementary prisms, the rays from which traverse the dilated pupil of the observer. This overlapping takes place perpendicularly to the axis of the spectrum, and consequently in a vertical direction in the arrangement adopted in my experiment.

The method proposed by Sir D. Brewster to determine the composition of the solar spectrum does not therefore appear to me adapted to the end in view. And, until it shall have been proved, that the colors of a spectrum, *perfectly pure,* change by the interposition of a medium placed near the prism, the change persisting at every other distance, *the existence of different colors in the same transverse element of the spectrum ought to be regarded as entirely hypothetical.*

I can therefore no longer admit the existence of different colors in the same part of the spectrum; I hold it as proved, that every particular tint arises from a single ray possessing a particular frequency of vibration, and a particular wave-length. I think altogether with Newton, that color is a characteristic sign; distinctive of the different elements contained in the beams of the sun and of luminous bodies; elements which are separated only and solely under the action of the prism in virtue of their different degrees of refrangibility.

In thus rejecting a means of analysis which has enjoyed until now much favor among philosophers, we ought to recollect

that Sir David Brewster is the author of very many beautiful and important discoveries confirmed by experiment;—works, from which the conclusion here arrived at, can never detract their merit; any more than the errors committed by Newton *on diffraction* and *the dispersion* of luminous rays by diaphanous bodies of different kinds, can ever lessen the glory which must belong to his optical researches, and his discovery of the system of the universe.

To return to the researches of Professor Draper. I say that they conduct, as do others heretofore known, on light and radiant heat, to a perfect analogy between the general laws which govern these two great agents of nature. I will add, that I regard the theory of their identity as the only one admissible by the rules of philosophy; and that I consider myself obliged to adopt it until it shall have been proved to me that there is a necessity of having recourse to two different principles for the explanation of a series of phenomena which at present appear to me to belong to a solitary agent.

I conclude, that the molecules of bodies, slightly heated, vibrate slowly, and produce long and invisible waves in the ethereal medium which surrounds them. As the temperature rises the molecular vibrations chiefly augment in extent, preserving the same isochronism; but some among them increase in frequency also. This increase, nevertheless, does not become very distinct until near the point of incandescence. Then a portion of the ponderable particles commence to vibrate more swiftly than the rest, and produce in the ether shorter undulations, which are consequently more refrangible; and of which some become visible; all contributing to increase the energy and variety of the radiation, until at last a great number of elements of luminous and obscure heat are found united in the radiant flux from sources of high temperature.*

There are, however, certain bodies whose state of molecular equilibrum is such that their particles possess a great facility of vibration; these particles acquiring long before the period of incandescence, altogether or partly, that rapidity of oscillation from

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* These views, being the direct consequences of the undulatory theory, are not only established in the memoir of Professor Draper here reviewed by M. Melloni, but also in an earlier paper inserted in the Philosophical Magazine, Feb., 1847; of which a translation is given in the Bibliothèque Universelle, June, 1847, respecting which M. De la Rive remarks in an introductory note, "Il nous semble, en effet, d'une importance assez grande par l'etude bienfaite et l'explication remarquable qu'il contient des phenomènes si singuliers de l'antagonism des rayons de lumière dans les effets chimiques." It also appears from that paper, that he has held them ever since 1842, and used them for the purpose of explaining those remarkable cases of chemical interference which Sir J. Herschel describes, on the hypothesis that the ethereal waves cause the particles of surfaces on which they impinge to execute vibratory motions.—(*Note of the Translator.*)

which arises visible heat. These bodies constitute the class of phosphorescent substances.

When one body combines chemically with another, its molecules acquire in an instant a very violent vibratory motion, and then may subsequently assume vibrations that are slower. This is what appears to take place in flames, which originate in the combustion of bodies; they commence almost always by a blue or violet light, and then become white or yellow.

But to return to the case in which light and heat are developed by elevation of temperature only; we discover that ethereal undulations incapable of acting on the organ of vision are not alone found in radiations coming from hot and dark bodies, but also in those that arise from luminous sources. These invisible rays are not homogeneous: they are of different kinds; and their specific properties are altogether analogous to those of color. Such is the origin of the curious phenomena of chemical and calorific transmission and diffusion which I had the honor to submit, many years ago, to the Academy.*

In conclusion, I cannot but express my admiration how the discovery of a series of facts, which seemed contrary to the theory of the identity of light and heat, has become now the fundamental basis of that theory. Who would not have thought at first sight, that the radiations of heat were of a nature altogether different from light, on seeing them transmitted in such different proportions through substances endued with the greatest transparency; traversing other bodies, strongly colored, in an immediate and instantaneous manner, and this in greater abundance than through some media perfectly limpid; and going in a single rectilinear path through a plate of completely opaque glass. Yet, nevertheless, these singular properties are the necessary consequences of the transparency and coloration of bodies for heat combined with different periods of the ethereal undulations. No one could have ever maintained the identity of light and heat until there had first been proved *coloration* of the one and the other of these agents, and the quality that every ray of dark heat possesses of propagating itself and being refracted in a solid body.

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* Sitting of Nov. 16th, 1841, and Feb. 1st, 1843.

ART. II.—*On the Cypress Timber of Mississippi and Louisiana;* by MONTROVILLE W. DICKESON, M.D., and ANDREW BROWN.

(Read before the Association of American Geologists and Naturalists, at the meeting in September, 1847, at Boston.*)

I. THE cypress† of Louisiana and Mississippi, is found to observe no very marked geographical preferences, except so far as respects proximity to the Mississippi river and its tributary water courses. It is distributed about equally, over the alluvial lands embraced in these states; yet it is by no means interspersed equally among the other forest growth; but it observes certain special hydrographical positions more or less detached and of variable area. It attains its highest perfection between the 31st and 32d degree of latitude.

The quantity of cypress timber distributed in detached locations, over the alluvial lands of both states, when contrasted with the amount of other kinds of timber, is variously estimated, at from one-tenth to one-hundredth part of the whole; and from the most reliable information we can obtain, as well as from direct observation, we arrive at the conclusion, that a seventy-fifth may be regarded as an approximate estimate. From defects and imperfections of growth, there can be but about one-fifth of that quantity made available for practical purposes, even where circumstances are favorable for securing it;—for its position and condition are usually such, as to preclude the possibility of obtaining the timber, except by floating it out of the swamps during seasons of overflow.

Its specific gravity is often such as to render that mode impracticable, it varying from ·7 to 1·2; the usual specific gravity is about ·9. Hence the greater portion, whose gravity is above that of water, must of necessity be left in the forests to waste and decay. On the above data, there will be, of the cypress growth of all kinds and qualities, (amounting to one seventy-fifth of all the forest timber of every denomination,) only one-third part fit for useful purposes: and one-third of this amount being of greater gravity than water, there will be available for domestic use not more than $\frac{1}{3}\frac{1}{5}\frac{1}{5}$th of the whole product of the forest. Such being the character of the primitive forests of Louisiana and Mississippi, with respect to the quantity of cypress timber, it must be obvious that much of this wood has already been exhausted; and as it is of very slow growth, the day cannot be very distant when it will altogether fail to furnish a sufficient supply for the markets of the above named states.

* Submitted as a Report upon the Cypress timber of Louisiana and Mississippi, from the authors, appointed as a committee upon the subject at the preceding meeting of the Association.

† Cupressus disticha; the Schubertia of Mirble.

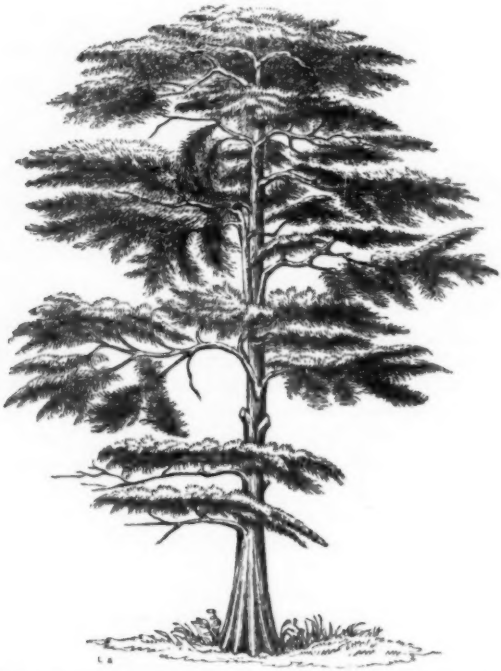
II. Of the local causes which determine the distribution and growth of cypress timber, the most essential one is, that *the soil in which it grows should for the greater portion of the year, be completely saturated with water.* The country abounds in basin-like depressions of the general surface, into which flow the surplus waters of the surrounding forests; and there are also elongated depressions, through which the waters from such basins find difficult outlets. Of such positions the cypress seems always to have availed itself; and where they are the most fully developed, *there* it obtains its maximum perfection. But much defective cypress growth is found also along the margins of shallow, sluggish bayous, through which the superabundant waters of the forests find difficult egress, on account of the undergrowth, drift wood, limbs, leaves or other obstructions. Such basin-shaped depressions containing cypress timber, are usually denominated "cypress brakes;" they are of various magnitudes, containing from one hundred to eight thousand "*tiers*" or cypress trees, of the lengths of forty, fifty, sixty and seventy feet, fit for rafting, and varying in diameter, at the top, from twenty to sixty inches. The largest and smallest are usually left in the forest. The greater number of these brakes are found near the Mississippi river and its branches, and the bayous which intersect the alluvial lands. These bayous are in great part formed by the efflux of the waters from such woodland basins; which by their depressions are constituted filtering receptacles, and through which, drain all the waters from the surrounding lands of greater comparative elevation. Such basins are found variously depressed below the general surface level of the surrounding country, the depression varying from a few inches to twenty-five feet or more. They are, in every instance, the ancient channels of the Mississippi river and its tributaries, or their tributary bayous, which have, from time to time, been more or less cut away. They intersect, (as it were,) their own channels, and close the mouths of such portions as are thus cut off, thus forming lake-basins more or less elongated; and from year to year, they are subject to a certain though imperceptible change in conformation, by receiving sedimentary matter from the floods and overflows of the rivers. The matter thus washed in, depositing itself more immediately around their margins, serves to lessen the declivity of their banks, and gives them, more and more, the slope of a basin, of variable curvatures. Vegetable matter enriches the margins of such lakes, which being retentive of moisture, soon become surrounded by a growth of cypress that continues to project itself into the basins as fast as the sedimentary matter elevates their margins, or the water recedes by any depression of the outlets through which they are drained. These outlets are at various distances above the low water mark of the Mississippi river, varying from twenty feet above, to the high water line, thus extending through a range of twenty-five feet; the

lowest depression up to the most elevated, being equivalent to a rise and fall in the Mississippi river extending through a series of forty-five feet. This is known to be its maximum, at least in the middle of the cypress growing region. However slow the process of filling up these lakes or basins, ancient beds of the river or other depressions, with sedimentary matter, yet being progressive, their bottom must finally become elevated to the level of the outlets; and when this is the case, cypress timber takes almost exclusive possession of the whole depression, and contributes, by its own depositions, to accelerate the process of elevation. Through an accumulation of imperfectly decomposed vegetable matter, formed on the spot, and washed in from the surrounding forests and cane-brakes, they continue to rise until they ultimately become filled, when other timber takes the place of the cypress; from which we perceive that no local position can perpetuate the cypress growth. Sections of such filled up cypress basins are not unfrequently exposed by the changes in the position of the river; they exhibit undisturbed, perfect, and erect cypress stumps, in a series of every elevation with respect to each other, extending from high water mark down to at least twenty-five feet below; measuring out a time when not less than ten fully matured cypress growths must have succeeded each other, the average of whose age could not have been less than four hundred years; thus making an aggregate of four thousand years since the first cypress tree vegetated in the basin. There are also instances where prostrate trunks of huge dimensions, are found imbedded in the clay, immediately over which are erect stumps and trees numbering no less than eight hundred concentric layers.

The formation of all the cypress basins is perfected by the deposition of a substratum of tenacious blue clay retentive and preservative of its contents, and resting on, or in proximity to, the primitive bottom of the rivers or isolated lakes. This substratum of clay continues to increase in thickness, proportionally as the depressed bottoms become elevated by their deposit, but never permits the superstratum of vegetable matter to exceed a few feet in thickness, before it blends into, and assumes the tenacity, of the understratum. Hence all the stumps inferior in position necessarily become involved in the accumulating bed of clay. These clay basins can contain little else than decomposing vegetable products; and in proof of this, after an unusually dry season and a burning of the woods, various pits will be found burnt into the ground as far as the fire could descend without coming in contact with water, and leaving little residuum or earthy matter. An inspection of these morasses at any time will satisfy an observer, that they are composed almost exclusively of vegetable products of every kind, formed on the spot or washed in from the surrounding forests. In most of these cypress basins there

can be little or no ingress of sedimentary matter but what is of vegetable origin, their distances from the river being such as to deprive the waters of their sediment, as there is usually a long continuation of brushwood and cane lands through which the waters must slowly pass. This seems to preclude the possibility that the basins can derive all their deposits of clay either from the contiguous soil or from annual inundation.*

Fig. 1.



III. The character and condition of the cypress timber in these basins, bayous and sloughs, is found to vary very much. That growing along the margins of shallow bushy bayous, is of inferior quality, affording but a small portion of timber fit for useful purposes; although oftentimes large, it is commonly of coarse texture and uncouth aspect; protruding at every elevation decaying limbs, which carry disease and rot into the body of the larger trees, rendering them more or less unfit for use: and those of smaller dimensions, in consequence of their limbs and incipient defects, are as often valueless. The general form of

* A specimen of this deposited material was exhibited to the Association, and the authors suggest that by a chemical examination much light will be thrown upon this subject, by determining how far it is possible that they may be accumulations of vegetable debris alone.

the trunks of bayou timber is represented by the drawing, fig. 1. They swell out toward their base and form into large spreading butments curving out into lateral roots strongly fortifying their trunks. This is mostly the form and character of the timber along the margins of all bayous leading from their several sources in the cypress basin to their principal water courses. Its defects in character and growth increase on approaching the principal

Fig. 2.

streams, and, inversely, improve in receding from them towards the woodland-basins; here it attains its highest perfection, exhibiting trunks not unusually of enormous proportions. It towers to a height, in some instances, of a hundred and twenty feet, without a limb, with a circumference at top, often exceeding sixteen feet, and at butt more than twenty feet, and this above the usual swell near the base, (fig. 2.) These cypress basins or swamps present an interminable array of stately columns, shooting up their tall and symmetrical shafts, and supporting a dome-like ceiling which excludes half the light of day. The columns are crowded closely together, and the observer is struck with the uniformity of elevation which they maintain, although varying much in diameter. These fine cypress columns terminate abruptly, under a cap, consisting of a few disproportionate and inconsiderable limbs, altogether constituting a kind of vaulted ceiling; and there is so perfect a reflection

of sound from it, that falling timber often causes a reverberation throughout these silent and sombre shades to a distance of ten miles. But while the tops of the cypresses are so disproportionate, it is not so with their roots; for they ramify through the soil in every direction extending from fifty to seventy-five feet from the body of the parent stems; some remaining parallel with the surface of the ground, whilst others penetrate deep into the more consolidated subsoil or under strata of clay; and they are thus so fortified that a cypress is rarely torn up from the ground in which it grows. The roots which they shoot out horizontally to such distances from their trunks, always assume *wave-like flexures* with respect to the horizon; the most prominent part of the convex curve rises within a little distance of the surface of the ground, and from them projects a series of perpendicular cone shaped protuberances usually called "knees," which are from three to thirty inches in circumference at the base, and rise to a height varying from two to ten feet; these knees growing from the innumerable interlacing roots in a dense forest of cypress timber are closely crowded together, and resemble (in all but their color) the stalagmites on the pavement of some enormous cavern; to which a cypress basin, take it all in all, is not unlike. The bases of these knees are usually very much enlarged beyond the size of the roots; thence they proceed and terminate upwards, in an obtuse point, from which protrudes neither leaf nor limb. Their texture is light spongy or cellular, and by means of them, the roots, although totally submerged, have a connection with the atmosphere. We suggest that this is the function fulfilled by the knees. The series of roots from which the knees project are of different structures and economy from those by which the tree is more directly sustained. They are of much the same cellular character with the knees; while the other roots are more compact and woody, and penetrate, at every angle, deep into the more solid material of the morass. When this means of communication between the roots and the air, is rendered inefficacious by the annual overflow of the river, raising the water in the swamp-basins above their summits, another is provided for in the body of the trees themselves. An unusual swelling of the butts of the tree takes place, arising from an enlargement and continuing up of the superficial or knee-bearing roots. (Fig. 3.) Such enlargements never fail to rise *to the top of the highest water level*, and must (in some instances) attain an elevation of at least twenty-five feet; so that when the knees are no longer available, the same kind of structure is continued up the body of the tree to where they come in contact with the atmosphere.

Fig. 3.

IV. In the texture and quality of cypress timber there is a very considerable variety, depending, in a great measure, upon the condition of the localities where it is produced. That growing along the bayous is usually much smaller, more scrubby and of a stunted body, giving out limbs, more or less large, at short distances from the place where the base ceases to swell, all along its body, and enlarging into a wide spreading top. They have but little resemblance to those growing in the basins. A great portion of the cypress timber growing along the sloughs, around the margins of lakes and imperfectly formed basins, is of this description, being coarse, defective, and knotty; affording a very inconsiderable amount fit for market. But the timber growing in the more perfectly formed basins, seems to attain all the perfection of its nature, furnishing the best quality of timber for architectural purposes.*

One specimen somewhat over seventeen inches, was found to contain three hundred and eighty annual layers varying in thickness from the $\frac{1}{\frac{1}{2}\frac{1}{0}}$th part to the $\frac{1}{4}$th of an inch. In a tree of not more than forty-two inches, we counted over sixteen hundred rings of growth; they decreased in thickness on receding from the centre until one inch contained not less than ninety-five. From all this it may be safely presumed that there are cypress trees in the forests numbering over two thousand years.

V. The diseases to which the cypress is liable are few in number; they affect it in the form of rot. That species of decay to which it is most liable, shows itself in partial and detached spots at greater or less distances, but often in very close proximity to each other. It is a decomposition of the woody fibre to which the tops and central parts are the most exposed, and which, when affected, appear as if operated upon by worms. This disease affects more or less, one-third of the cypress timber, irrespective of age or size. It makes its appearance more immediately in the heart of the tree, seldom as low as its base; but some where intermediate between that and the top, and spreading as it descends, until, in very many instances, the whole upper part of the tree is rendered an entire rotten mass. Timber affected in this way is denominated by raftsmen, "*Pecky.*" The timber of some basins is much more liable to this disease than that of others, but there is this peculiarity attending it, that the cutting down of the timber arrests its further progress; and timber thus affected, although not as strong, is found to last as long as that which is very sound. Nor does this disease seem to hasten the ultimate termination of the life of the timber affected by it; for it is found in those of every age, and continues during the whole life time of the plant; but never extends to the active sap vessels.

* Various specimens were here submitted to the Association, descriptions of which are necessarily omitted, as they would be unintelligible without the specimens at hand. Dr. Dickeson will be happy to submit them to the examination of any gentleman who will favor him with a call at Philadelphia.

The disease of cypress timber incidental to age, and which terminates the period of its existence, is a rot affecting its base, or the part swollen out in consequence of overflow, and more particularly that part on a level with the ground. This rot commences in the centre of the base and continues during a great portion of the life time of the tree, extending outward and upward, until, ultimately, the whole becomes so decayed that it is no longer able to support the weight of the tree and it falls to the ground. In consequence of this rot at the base, which usually terminates at the top of the overflow, it is always necessary to cut the timber down above the line of such overflow, in order to avoid the hollow and incompact quality of the wood constituting the swelling and expanding base, which often spreads out to an area of fifteen feet and contains no more solid matter than exists in the same column above.

ART. III.—*Account of some Researches on the Protein bodies of Peas and Almonds, and a Body of a somewhat similar nature existing in Oats;* by JOHN P. NORTON, Professor of Chemistry applied to Agriculture, Yale College.

THE results given in this paper were obtained during the past year in the Laboratory of Prof. G. T. Mulder, at Utrecht, in the Kingdom of the Netherlands. In that Laboratory more has been done to throw light upon the protein compounds than in any other. Prof. Mulder first gave the name of protein, and first established it as the basis of a large group, both of vegetable and animal substances. For many years his attention has been directed to this subject, and his experience suggested methods, as well as new points for enquiry, which led me to extend my investigations far beyond the limit at first proposed.

In a paper upon the oat, published originally in the Transactions of the Highland Society of Scotland, and recently republished in this Journal,* I first called attention to the existence of a protein compound in that grain, but was not then able to speak with certainty as to its peculiar properties and composition. The legumins, as they have usually been called, of almonds and peas were also examined, both for the sake of comparison, and because the results hitherto obtained have not been entirely satisfactory.

My first step was a comparative and qualitative examination of these three substances. The peas employed were of a common green variety, ground to a fine meal. The almonds were sweet, being also ground, and the oil for the greater part separated by a powerful pressure. This expression of the oil is a great facility in the preparation of legumin from almonds, as otherwise a species of emulsion is formed, rendering filtration almost impossi-

* ii Ser., vol. iii, pp. 222, 318.

ble. The oats were of common varieties, ground tolerably fine. Oat meal was first tried, but the kiln drying of the grain preparatory to a separation of the husk, seemed to have changed the solubility of the protein body. In my former remarks upon the properties of this body, I said that it was largely soluble in cold water. On a second examination this did not appear to be the case, and repeated experiments satisfied me that the large quantity obtained formerly arose from the addition of a drop or two of ammonia in order to prevent the liquid from souring, it being very warm weather at the time.

There is, however, in the oat a substance, which though in small quantity, is readily soluble in cold water. It is precipitated by dilute hydrochloric or acetic acids, but *not instantly*, it *falls slowly*, and in a state of *minute division*.

Nothing is precipitated *at first* upon boiling the solution, but a small quantity appears *after cooling*.

It is partially dissolved in an excess of acetic or hydrochloric acid; entirely on the application of heat.

It dissolves readily in an excess of ammonia.

It is precipitated in considerable quantity by both the neutral and basic acetates of lead.

The legumin of almonds, is extremely soluble in cold water, and in very large quantity. On the addition of a single drop of hydrochloric or acetic acids, a *most abundant* precipitate *falls at once* and in *large flocks*. When the solution is boiled, a *very considerable* precipitate falls almost instantly.

It partially redissolves in an excess of acetic or hydrochloric acid, entirely when heat is applied.

It dissolves in an excess of ammonia, and is precipitated in quantity by both the basic and neutral acetates of lead.

The legumin of peas, is equally soluble in cold water, and also in very large quantity. Like the above, it *falls instantly* and in *large flocks* on the addition of *very dilute* acetic or hydrochloric acids.

It is *not precipitated at all* by boiling.

It dissolves like the others in an excess of acetic or hydrochloric acids, and when aided by heat, quite rapidly.

It dissolves also in ammonia.

The addition of a neutral or basic acetate of lead *does not* cause a *large precipitate*, but merely renders the solution *cloudy*.

It will be observed that while in many properties these three substances coincide, there are some striking points of difference between the legumin of peas and the other two. These will be referred to again in connection with the analyses now to be given.

In the preparation of the above substances, the solutions were made by mingling the meal or crushed grain with distilled water, and rubbing thoroughly in a porcelain mortar. A large quantity of water was added afterward, and the vessel allowed to remain

undisturbed in a cool place during twelve to sixteen hours. Much difficulty was experienced in filtration. The coarser particles were removed by a doubled linen cloth, and the greater portion of the finer by repeated filtrations through paper, doubling the filters toward the close. Even after four or five filtrations however, the liquids generally remained somewhat cloudy. The precipitates therefore, after being thrown down by acetic acid were collected, washed, and dissolved in dilute ammonia, by the aid of a gentle heat not above 60 to 70 degrees Celsius. The solution almost always became colored; if the ammonia employed was strong, and the heat nearly at the boiling point, it turned almost black. The weaker the ammonia and the lower the heat, so much the lighter was its color. These solutions were afterward filtered, and the substance again thrown down by acetic acid. The coloring matter invariably went with the precipitate, leaving the filtered liquid almost entirely colorless.

The precipitate, thoroughly washed, was next boiled in alcohol and ether severally, until either ceased to extract anything; it was then considered pure, for so far as our knowledge of these substances at present extends, we have no more certain method of purification.

In determination of the carbon and hydrogen, I have employed the ordinary method, but for the nitrogen I have preferred the method of Dumas, substituting bicarbonate of soda, for carbonate of copper, and introducing one or two additional precautions. This method has given me most admirable results. I have tested it in various ways, and have compared it with a method of Prof. Mulder's, in which the substance is burned in an atmosphere of pure nitrogen, its accuracy has been most satisfactorily proved, but it is too complicated for general use. On burning the same substance by the two methods, I obtained in the one case 17·32 per cent. and in the other 17·355. Dumas's method is so simple, and with due precaution so accurate, that it has taken the place of all others in the Utrecht Laboratory since my series of experiments upon it.

For the determination of the sulphur I have tried a variety of methods. The first was that of burning with carbonate of potash and nitre, in a platinum crucible over a lamp, the substance being first mingled with the two salts of potash in a mortar and thrown into the crucible in small quantities as the carbon burned away. The melted mass is dissolved in dilute hydrochloric acid, and the sulphur thrown down as BaO, SO^3. There is great danger of deflagration by this method, although with care, very good results may be obtained. I also tried mingling the substance with a large quantity of carbonate and a very small quantity of nitrate of potash, and burning in a glass tube to prevent loss. It was difficult, however, to control the combustion, and the caustic potash formed almost always attacked the glass, forming a quantity of soluble silica. This last objection applies also, I think,

to a method recommended by Kemp, that of mixing chlorate of potash with sand.

The method which I finally adopted was suggested by Prof. Mulder. The substance to be burned is mingled *thoroughly* in a silver crucible with two or three times its bulk of caustic soda; a layer of the soda is placed upon the surface of the mixture so as to entirely prevent the escape of any sulphur without coming in contact with it. Heat is applied very gently, and through the water of the soda the whole mass in the crucible becomes semi-fluid. The heat is gradually increased until this water is driven off, and the remaining carbon is burned away by the addition of a few crystals of nitrate of potash. The mass is now dissolved in water, and after the addition of an excess of hydrochloric acid, the sulphur is determined by baryta in the usual way.

I at first attempted to determine the phosphorus also by this method; after the sulphate of baryta was separated, ammonia was added until the solution became neutral, phosphate of baryta ($2BaO+PO^5$) immediately fell, this was separated, weighed, and afterward analyzed, by way of control. Like all processes depending on *neutralization*, this could not be absolutely depended upon, and I often obtained the most widely differing results. It is possible also that during the combustion with caustic soda and nitrate of potash, phosphuret of carbon or some compound of that nature might be formed and given off.

The method which finally succeeded best was that of Berthier. The substance was decomposed by nitric acid, a weighed piece of bright iron added, and the phosphorus determined as $Fe^3O^4+PO^5$. The great objection to this method is the time required for the decomposition of the substance; several hours of steady boiling are necessary. I attempted an improvement by dissolving the substance in nitric acid in a platinum basin, and burning away the carbon by a little nitrate of potash; this mixture however always exploded with great violence.

Having thus mentioned the methods adopted, I now proceed to the results of my analyses, and will begin with the legumin of almonds.

I have made in all of these substances two or three distinct preparations, and have varied a little the mode of obtaining them in each instance. So many circumstances may alter the composition of an organic body that such a precaution seems to me always necessary.

The legumin first examined was dissolved in *strong* ammonia, *before* boiling in alcohol and ether. No very large quantity of any foreign substance was extracted from it by the two latter liquids. It was almost entirely white and was reduced to a fine powder without difficulty. It was dried at 130° Celsius, (266° F.,) in an oil bath, and the analyses gave the following results.

	1.	2.	3.	Mean.	Ash deducted.
Carbon, per cent.	50·38	50·49	· · ·	50·42	50·50
Hydrogen,	6·63	6·50	· · ·	6·55	6·56
Nitrogen,	17·26	17·32	17·35	17·30	17·33
Oxygen,	24·20	24·19	· · ·	24·19	24·24
Sulphur,	0·30	0 33	0·35	0·32	0·32
Phosphorus,	1·07	0·99	1·13	1·05	1·05
Ash,	0·16	0 18	· · ·	0·17	· · ·
	100·00	100·00		100·00	100·00

Two of the above nitrogen determinations were by Dumas and the other by Mulder's method. Two of the determinations of sulphur were by burning with carbonate and nitrate of potash, and the other with caustic soda and nitrate of potash. Of the phosphorus determinations, two were by the phosphate of baryta, and the other by Berthier's method.

A second preparation of legumin was made, and was boiled in alcohol and ether *before* dissolving in strong ammonia. It was dark colored, was quite sticky previous to drying, and when dry was gummy in appearance. The result of analysis was as follows.

	1.	2.	Mean.	Ash deducted.
Carbon, per cent.	50·79	· · ·	50·79	50·97
Hydrogen,	6·62	· · ·	6·62	6·635
Nitrogen,	17·09	· · ·	17·09	17 15
Oxygen,	· · ·	· · ·	24·305	24·40
Sulphur,	0·29	0·26	0·275	0·27
Phosphorus,	0·65	0·49	0·57	0·575
Ash,	0·33	0·40	0·35	· · · ·
			100·00	100·00

In the carbon, hydrogen and nitrogen, the results approximated so nearly to the analyses above, that it was unnecessary to repeat them. The only essential difference is in the phosphorus. I made several experiments to determine how far the phosphorus in these bodies might be in the state of phosphoric acid, and therefore in combination with the alkalies of the ash. None of them were satisfactory, but they indicated that a portion of it at least, was so combined.

Still a third quantity of this substance from almonds was prepared, but it was, after precipitation by acetic acid, only boiled in alcohol and ether, and not dissolved in ammonia. The color was a pure white, and it was evidently soluble in strong ammonia. These were the results of my analyses.

	1.	2.	Mean.	Ash deducted.
Carbon, per cent	48·88	48·99	48·80	49·16
Hydrogen,	6·39	6·56	6·475	6·51
Nitrogen,	17·34	· · · ·	17·34	17·43
Oxygen,	· · · ·	· · · ·	24·135	24·27
Sulphur,	0·43	0 39	0·41	0·41
Phosphorus,	2·27	2·12	2 195	2·21
Ash,	0·55	0 56	0·555	· · ·
			100·00	99·99

The difference in the per-centage of carbon is extraordinary, and the more so as there is a nearly corresponding increase in phosphorus. The determinations of this last were both as $2BaO + PO^5$, agreeing when calculated from that salt directly, and also when it was analyzed as a control. This difference would indicate the removal of some impurity by means of the ammonia.

For the present I leave this part of my subject, and proceed to the results obtained from the legumin of peas. The method of preparation was the same as that employed for the almonds.

The first quantity analyzed was dissolved in ammonia *before* boiling in alcohol and ether. A large quantity of a yellowish fatty substance was extracted by these last. This legumin was nearly white, and gave the following results.

	1.	2.	Mean.	Average.
Carbon, per cent.	50·57	50·10	50·33	50·72
Hydrogen,	6·47	6·57	6·52	6·56
Nitrogen,	15·60	15·69	15·645	15·77
Oxygen,	23·52	23·84	23·68	23·87
Sulphur,	0·72	0·80	0·76	0·77
Phosphorus,	2·43	2·16	2·295	2·31
Ash,	0·69	0·84	0·77	....
	100·00	100·00	100·00	100·00

One of the above determinations of phosphorus is as phosphate of baryta ($2BaO + PO^5$) and the other by Berthier's method. The quantity seemed so very large that I made a third trial and obtained nearly the same per-centage again. The second preparation was dissolved in ammonia *after* boiling in alcohol and ether. The result was interesting.

	1.	2.	Mean.	Ash deducted.
Carbon, per cent.	49·97	49·93	49·95	50·57
Hydrogen,	6·78	6·84	6·81	6·90
Nitrogen,	16·63	...	16·63	16·84
Oxygen,	....	...	23·41	23·70
Sulphur,	0·31	0·34	0·325	0·33
Phosphorus,	1·61	1·68	1·645	1·66
Ash,	1·23	...	1·23	...
			100·000	100·00

I had not a sufficient quantity of substance to make a second trial of nitrogen in this instance, but made one upon a portion of another preparation of the same kind. The result was 16·25 per cent., the phosphorus was 1·16 per cent. These two though not precisely the same, are as near as could be expected in two distinct preparations, and show a very decided difference from the first analyses, where the boiling in alcohol and ether took place before dissolving in ammonia. In that case the alcohol became highly colored and separated a large quantity of a white substance, no doubt an impurity, very possibly some ammoniacal combination rendered insoluble in alcohol or ether by the action of ammonia.

The above per-centage of ash is I think too high. I had but a sufficient quantity for one determination, and these substances burn with so much difficulty that a little carbon sometimes remains even after hours of exposure to a red heat and a current of air.

We now come to the protein body in oats, avenine, as it has been called by Prof. Johnston. In the preparation of this substance I have met with great difficulty, because the quantity dissolved by water is very small. If the weight of oats employed was more than four or five pounds, the solution became so large as to sour before it was possible to filter it the four or five times necessary to make it quite clear. Three several preparations were made, taking four or five pounds of oats each time, and nearly two weeks were occupied in the filtrations, boiling, &c.; but the quantity of avenine resulting from so much labor was only sufficient for one complete analysis, and even then only permitted me to employ the smallest allowable weights. I have never been able to obtain it white like the legumins of peas and almonds, even on the first precipitation; it is of a brown color, and retains this color through all of the subsequent treatment. Alcohol and ether extract a large quantity of whitish matter, and become highly colored. This extract burns readily with a yellow flame and is probably almost entirely fatty.

The following is my single analysis of the avenine.

		Ash deducted.
Carbon, per cent.	51·97	52·36
Hydrogen,	6·80	6·85
Nitrogen,	14·65	14·76
Oxygen,	23·98	24·16
Sulphur,	1·05	1·06
Phosphorus,	0·80	0·81
Ash,	0·75	. . .
	100·00	100·00

Standing alone as this analysis does, and all of the determinations having been made upon small quantities, it cannot be considered as conclusive. Several analyses made from a different preparation afterward, were rejected on account of an impurity in the ether employed; they came however, so near to the above as in some degree to confirm their correctness. The chief points in which this analysis differs from the preceding ones, are as will be observed, the nitrogen and carbon.

Knowing that a large quantity of some protein body must still remain in the oats, I treated them, after extracting the avenine substance by means of water, with dilute ammonia. The solution was brown and exceedingly difficult of filtration. On the addition of acetic acid, a copious light brown precipitate fell at once. This was dissolved in dilute ammonia, and then reprecipitated by acetic acid. A cloudy liquid remaining above being

poured off, the precipitate was collected, washed and boiled in alcohol and ether. Large quantities of a white fatty matter were separated by this boiling. When no more foreign matter was extracted, the substance had become of a brownish white. It was tested for starch by iodine, but none was present. This was marked A. Another quantity from the same preparation was boiled in alcohol and ether *previous* to dissolving in ammonia. This was marked B.

Of A, I am only able to give one complete analysis, as the whole of the preparation only amounted to two or three grammes.

		Ash deducted.
Carbon, per cent.	52·81	53·270
Hydrogen, ...	6·88	6·940
Nitrogen, ...	16·66	16·810
Oxygen, ...	21·38	21·569
Sulphur, ...	0·59	0·595
Phosphorus, ...	0·82	0·825
Ash, ...	0·86	. . . .
	100·00	100·000

Of B, the analyses are more complete, as there was a much larger quantity of it. The results were as follows.

	1.	2.	Mean.	Ash deducted.
Carbon, per cent. .	51·21	51·54	51·375	51·82
Hydrogen, . . .	6·74	6·87	6·805	6·86
Nitrogen, ...	16·32	16·17	16·245	16·39
Oxygen, . . .	22·78	22·46	22·62	22·82
Sulphur, ...	1·08	1·12	1·10	1·11
Phosphorus, . . .	1·01	0·98	0·995	1·00
Ash, ...	0·86	0·86	0·86	. . . .
	100·00	100·00	100·00	100·00

This last was much lighter in color than A, and was dissolved in very dilute ammonia, the heat not being more than 70 to 80° Celsius. A, was dissolved in strong ammonia nearly at the boiling point. This would seem to have darkened the color and somewhat affected the composition.

It is quite possible with any of these substances to establish Mulder's assertion upon which so much of his celebrated protein controversy with Liebig has turned,—that by the action of dilute potash upon any of the protein compounds, a substance may be obtained which neither discolors silver when heated upon it with potash, nor produces sulphuret of lead when heated in a solution of acetate of lead. A small quantity of the avenine of oats for example, was dissolved in a solution containing one per cent. of potash, and exposed to a temperature of 80° Celsius, for one hour; it was then set aside for two weeks and occasionally shaken. At the end of that time, when precipitated by acetic acid, the precipitate answered perfectly the above condition. In fact it was *sulphur free*, deprived of that reaction which is characteristic of the presence of sulphur; as sulphuret of calcium is said to be desulphuretted when it no longer yields a black precipitate with

acetate of lead. When it is converted into gypsum, it is still said to be desulphuretted, although it contains sulphuric acid.

This point seems now to be virtually admitted even by Liebig, as through Fleitmann's paper an entirely new issue is joined, and the old one left untouched. Fleitmann's researches, made in the Giessen Laboratory, showed that protein, when burned with nitre, yields a weighable quantity of sulphuric acid. This was true, but still it had nothing to do with the original question. In consequence of Fleitmann's paper, Mulder found himself obliged to review the entire protein question, the fact noticed by Fleitmann being one which he had overlooked.

This review is still proceeding, but already some results have been arrived at, which seem likely to place Mulder's name even higher than it has stood before. He considers "that albumen, horse and cow hoofs, &c. contain sulphur in the state of sulphuret of amid (SNH^2),—that protein from albumen contains variable traces of hyposulphurous acid, $S\ O^2$, in weighable quantities,—that this acid is produced by the decomposition of two equivalents of sulphuret of amid (SNH), which by the influence of alkali and two equivalents of water ($2HO$), produce an equivalent of hyposulphurous acid and two equivalents of ammonia ($S\ O^2$ and $2NH^3$),—that therefore protein yields variable quantities of hyposulphurous acid, and consequently contains the sulphur under a form which has nothing in common with that in which it originally existed,—that cow horns and fibrin consist of sulphuret of amid (SNH^2) with a body differing from protein only in the proportion of oxygen."

Hitherto, as Mulder acknowledges, he has been unable to separate from protein the last traces of this hyposulphurous acid, neither has he or any one else been able to separate the last traces of incombustible substances. He considers that the one no more belongs to the formula of protein than the other, and deducts the sulphur as sulphuret of amid.

The following are the results obtained in this way from albumen.

		Deducting the S, as $SNH2$.	
Carbon, per cent. .	53·6	53·6	55·1
Hydrogen, . .	7·0	6·9	7·0
Nitrogen, ...	15·7	14·5	14·9
Oxygen, ...	22·3	22·3	23·0
Sulphur, ...	1·4	. . .	. . .
		97·3	100·0

The protein from cow hoofs gave—

		Deducting the S, as $SNH2$.	
Carbon, per cent. .	50·2	50·2	55·2
Hydrogen, . .	6·8	6·3	6·9
Nitrogen, ...	17·3	13·3	14·7
Oxygen, ...	21·1	21·1	23·2
Sulphur, ...	4·6	. . .	. . .
	100·0	90·9	100·0

This therefore Mulder considers the true composition of *desulphuretted* protein. Fleitmann's analysis of protein, made in the Giessen Laboratory, gives nearly the same result when the sulphur is deducted.

Cow horns and fibrin, as observed above, he considers oxyds of protein.

The protein of cow horn is as follows:

		Deducting the S, as SNH_2.	
Carbon, per cent.	50·1	50·1	53·8
Hydrogen,	6·8	6·3	6·8
Nitrogen,	16·2	13·2	14·2
Oxygen,	23·5	23·5	25·2
Sulphur,	3·4	. . .	. . .
	100·0	93·1	100·0

And of fibrin:

		Deducting the S, as SNH_2.	
Carbon, per cent.	52·7	52·7	53·8
Hydrogen,	6·9	6·8	6·9
Nitrogen,	15·5	14·6	14·9
Oxygen,	23·9	23·9	24·4
Sulphur,	1·0	. . .	. . .
	100·0	98·0	100·0

At the time when Prof. Mulder made this beautiful discovery, my analyses of legumin from peas were nearly completed, and his attention was turned to them also. On investigation he was led to suspect that the phosphorus might be present in the same form as the sulphur, that is, as phosphuret of amid. It was therefore also deducted, and the following shows how correct were his suspicions.

	Legumin of peas.	Deducting the S and P, as SNH_2 and PNH_2.	
Carbon, per cent.	50·72	50·72	53·4
Hydrogen,	6·56	6·32	6·6
Nitrogen,	15·77	14·14	14·9
Oxygen,	23·87	23·87	25·1
Sulphur,	0·77	. . .	. . .
Phosphorus,	2·31	. . .	. . .
	100·0	95·05	100·0

The legumin of peas, therefore, may be added to the oxyds of protein.

Since leaving Utrecht my attention has been turned to the analyses of the avenine of oats before given. I deducted the sulphur and phosphorus, as sulphuret and phosphuret of amid, and the result was as follows.

	Avenine of oats	Deducting the S and P, as SNH_2 and PNH_2.	
Carbon, per cent.	52·36	52·36	54·1
Hydrogen,	6·85	6·67	6·9
Nitrogen,	14·76	13·54	14·0
Oxygen,	24·16	24·16	25·0
Sulphur,	1·06	. . .	. . .
Phosphorus,	0·80	. . .	. . .
	100·00	96·73	100·0

I therefore may add this substance also to the class of oxyds of protein. When it is remembered that but one complete analysis was made, and that upon small quantities, the above is a remarkable approximation to the other results. From the dark color of my preparation, I should have expected the carbon to be higher than in the other analyses. It is worthy of observation that the nitrogen in that preparation of peas, which was dissolved by ammonia after boiling in alcohol and ether, very nearly corresponds to that obtained in the ammoniacal extract from oats. The differences in carbon and in sulphur and phosphorus, are however so great as to show that they cannot be considered identical. The coincidence is sufficient to suggest the idea that some ammoniacal compound may be present, constituting an impurity, the removal of which would leave the same oxyd of protein obtained in the first preparation from peas, or in the extract by water from oats. The second preparation from peas was exposed to the action of ammonia after boiling in alcohol and ether, but in the first preparation the boiling, succeeding the action of ammonia, seems to have separated this ammoniacal or other impurity. In the ammoniacal extract from oats, it is probable that through the ammonia acting upon the whole grain, some additional substance was dissolved containing a larger quantity of carbon. In pursuance of the idea of an ammoniacal combination, Prof. Mulder advised me to try some new preparations, by treating with very dilute potash (one per cent.) after precipitation by acetic acid, solution in ammonia, and reprecipitation by acetic acid. The substances dissolved slowly, but entirely and with little discoloration. The solutions were allowed to stand nearly a week, exposed to no higher heat than that of the sun. Acetate of lead did not blacken them, thus showing that the legumin was not decomposed by the potash. No ammoniacal fumes were perceptible when a rod dipped in hydrochloric acid was held over the vessels. At the end of a week acetic acid was once more added, and the washed precipitate boiled in alcohol and ether as before. Owing to an accidental impurity in the ether employed, which was not discovered until too late, the results of analysis upon these substances could only be considered approximations; they indicated however that the quantity of nitrogen in the bodies obtained from oats and almonds, remained unchanged by the above treatment. Limited time prevented my attempting other methods. So far as regards the almonds, if the excess of nitrogen above the protein group be an impurity, it is one of a very constant nature; for in three preparations by methods each time a little varied, I have obtained as before shown, the same percentage of nitrogen. This is an interesting field for investigation, and one which I only left on account of other and more pressing business.

I am aware that my results as to the peas and almonds differ somewhat from most previous analyses; but so much care was taken in their purification, and so many concurrent determinations were obtained, both in analyses of the same, and of different preparations, that I feel much confidence as to their correctness. I leave the subject for the present with the hope, that my labors may in one direction throw a little light upon one of the most warmly contested questions of the present day, may open the way to some future enquirer who shall have the great happiness of definitely answering many of these long vexed questions.

ART. IV.—*Letter on Philosophical Induction;* by JAMES D. WHELPLEY. (Addressed to one of the Editors of the Journal.)

* * * I wish to throw out a few thoughts regarding the true method, or what seems to me the true method to be adopted in the scientific study of nature, material and organic—the method, I mean, of *induction by analogy*, (shall it be called?) as distinguished from hypothesis.

When, for example, in the paper which I have before me,* you infer that the relative lengths and angles, of the axes of the molecules of a crystal, may be known from the primary form of the crystal itself, that is what I mean by analogical induction. The analogy is between the mass of the crystal and the single molecule; the induction is from the known to the unknown.

Another species of the same induction, identifies a substance by its properties; as, from the chemical evidences of chlorine, to infer the presence of chlorine.

Nor is it easy to confound either of these with a third kind, the induction from antecedent to consequent—as when, from the marks of fire on a body, I infer that fire has passed over it, or when, from the elastic rebound of a ball, I infer the cause to lie in a force accumulated in the ball.

In all these instances, there is an induction from the known to the unknown. As, from the properties of chlorine, to the substance chlorine; from the bound of the ball, to the elastic force of the ball; from the form of the whole crystal, to the form of its molecules; which may be expressed thus:—

Induction: 1. From known PROPERTIES to unknown *substance.*
2. From known EFFECT to unknown *cause.*
3. From known SHAPE to unknown *form.*

It seems to me impossible, by any effort of logic, to show that one of these methods of induction is less philosophical or exact

* Mr. Whelpley refers to the paper on Cohesive Attraction, p. 364, ii ser., vol. iv.

than another, yet they are all strictly analogical; as may be seen, when, from our previous notion of chlorine, on witnessing its properties a second time, we recognize it. The identification is a very complex process, and involves more conditions of thought than the identification, or naming, of a color, or of any simple property of bodies. When we identify yellow with yellow, or sour with sour, there is no idea of a substance conveyed, as there is in chemistry.

So also in the observation of cause and effect, it is no analogical induction of cause, to expect that because a thing has happened once it will happen again under the same conditions: but when the imagination works in close conjunction with the understanding, reason takes cognizance of something more than mere sequence—namely, of a *principle* in matter, which goes under the general names of elasticity, equilibrium, action and reaction and the like, to which, as to the cognate idea of a simple substance, it gives various names in various departments of observation.

Nor can that induction be esteemed analogical, which merely identifies names;—as of crystals by their forms, or of birds by their feathers and dimensions: but when a profound observation of a crystal, or animal, shows it to be a species *in esse*, i. e., as composed of certain original forces, as of those of gold and chlorine, or of certain organic or vital energies, assembled in a certain mode, and constituting a species of animal or plant, should we not agree in distinguishing this process of the mind as analogical and inductive—as passing from the known to the unknown in a scientific manner?

That this distinction of the two methods is true in practice, seems to me evident from a comparison of the two methods of classification, one called natural, the other artificial—one seeking the true and essential characteristic of the species, the other aiming only at identification of properties and names.

I have got farther into this distinction than I intended, and am now compelled, in a manner, to pursue it to the end: though there will be nothing new or unusual to yourself in these distinctions, at least in practice, or to any other person as well versed in all processes of induction, it may amuse you to see them thrown into a shape that is meant to be logical. Under this pretext, then, I will venture to follow the idea as it leads.

Now, to distinguish the analogical method from that of mere classification, or scientific memory, we may compare the system of Linnæus with that of the modern chemists, and a few modern botanists and zoologists: the one ending in an act of memory, the other in an act of judgment: the one merely observing, the other cognizing, or profoundly knowing. What, for example, is more profound than the science of the simple elementary *forces* or *substances*—as of oxygen, hydrogen, platinum, &c., the simple elementary *motions*, as of electricity, heat, light, &c., and the

simple elementary *forms of forces or substances*, as of the axial forces of the molecules, elasticity, cohesion, &c.? By a perfect and essential knowledge of these, the philosopher must construct his framework of the material universe, as by his similar knowledge of the *organic* forces and forms of forces, he may hope at some future time to attain an idea of life.

With these distinctions it is perhaps possible to separate the notion of an hypothesis, or of the hypothetical method, from the truly inductive or analogical.

In the celebrated Newtonian hypothesis of particles of light projected from phosphorescent or reflecting surfaces; in that of caloric, which supposed heat to be a substance; in that of the electric *fluids;* in that of phlogiston,—of the resisting ether in the interplanetary spaces,—of the nebulous matter,—of the magnet in the earth's center,—of the mesmeric fluid,—of the Swedenborgian spheres,—of the vitality of matter,—of the universal solvent,—of the liquor of life,—of the strumous humor of the Homœopathists,—of the hard atoms of Wollaston,—of churchyard ghosts,—of the Brunonian tonic atomy, and atonic tonicity, —of the Mahommedan paradise,—transubstantiation,—mesmeric spheres,—the vis medicatrix,—and the innumerable tribe of hypotheses including all the deities of Egypt and India, numbering an hundred thousand, invented to account for unaccountable events,—or substituted for the laws of nature, life, the soul, and of Omnipotence, the logician has a great choice of illustration, to distinguish a theory founded on induction, from hypothesis invented by mere imagination.

An hypothesis may be fancifully compared to that old fashioned machinery used by the early inventors, which brought together a vast complication of wheels, levers, pivots, pulleys, and axles, to accomplish movements that are now attained by one or two simple connections. To account for a change in the weather or a blight in corn, the Egyptian invented a complete deity, with all the attributes of man, demon, and angel, united;—and to account for the phenomena of heat, light, electricity, magnetism and chemical changes, no less than seven or eight different fluids and essences have been proposed, to the utter confusion and stagnation of all science.

Certain changes of size and density are observed in bodies, attended by certain chemical results and nervous sensations, and instantly a 'caloric' is invented, a thing without shape, use, property, energy, or law in itself—a mere alchemistical ghost. Again, it is observed that iron and other metals, under a certain treatment, acquire a certain position, when left free, in regard to the earth's axis, when at once starts up another spectre in the shape of a magnetic *fluid*, divided into its particles, but without any imaginable shape, properties, or qualities, a mere burthen to thought, and creating a thousand difficulties without solving one.

Among these philosophical placebos, the latest, I believe, is the "new imponderable," to account for the magnetic phenomena of the human body, proposed, like the others, in lieu of a scientific induction. Even the majestic intellect of Humboldt gave in to the prevailing method, and tolerated an hypothetical ether supposed to impede the planets by impinging against their sides.

This host of "imponderables," lie with a ponderous weight upon the mind, though in substance they be lighter than air, nay, composed of that stuff that dreams are made of. They consume more valuable thought than the syllogisms of the scholastics, and when it is considered how many thousands of ingenious and powerful intellects have exhausted their whole energies in the endeavor to build worlds out of this dust in the mind's eye,—this nebulous matter of intellect, this hypothesis,—a mixed feeling of compassion and despair rises in the throat;—and this too while we are hearing lectures on the inductive philosophy, and reading "Accounts of the Organon," and triumphing in the scientific advancement of the age. The cry of exultation and progress was never louder than about twenty years since, when the human intellect groaned under the heaviest mass of hypotheses that science was ever burdened with. At that very time too, when the only perfect theory known was the Newtonian one of gravitation, nothing was more customary than to pity the ancients, and smile over the vagaries of Plato and Heraclitus,—when indeed, the secret of hypothesis and of true theory were alike profoundly understood by those ancients; though applied only to the facts and processes of the intellect, in a style so elevated and exact as to have the air of inspiration.

Yet, one may venture to predict from the tone of the best scientific writers of this day, and from the progress and method of theorizing employed by the most intelligent investigators, that the reign of the hypothetical method is at an end, and that the true inductive method will soon carry our knowledge to its height.

New York, Nov. 6, 1847.

ART. V.—*On the Resistance presented by Fluids to Electric Conduction;** by EBEN N. HORSFORD, Rumford Professor in the University at Cambridge, Mass.

THE resistance of liquids to conduction in the galvanic circuit has been frequently the subject of investigation. A general use of the results arrived at, fails usually in this particular, that the influence of polarization on the transition surfaces has not been regarded as it should be. In fact only a single investigation is known to me, in which the resistance a liquid presents, viz.

* Translated from Poggendorff's Annalen, Bd. lxx, s. 238–343.

sulphate of copper, free from this varying influence, has been measured.*

As I wished to know the conducting power of several other liquids, I embraced the opportunity offered to me in Prof. Buff's Physical Cabinet at Giessen, to enter upon a proposed investigation, having this end in view. It was unfortunately impossible for me to complete the labor which my original plan embraced, before the time fixed for my return to America. Well wishing friends have nevertheless advised me to publish the essential results of my investigation, since several of them may have a practical value.

The apparatus and general facilities for this investigation, and above all the counsel of Prof. Buff in the difficulties which were constantly presenting themselves, were extended to me in the same spirit of generosity that distinguishes the great leader of the Chemical School at this University.

For the reception of the fluids, whose bearing against the electric current was to be proved, I employed a rectangular trough of thick, firm wood 0·3 meter long, 0·075 meter wide, and of 0·075 meter in depth. The interior was thickly overspread with shellack varnish to prevent, or as long as might be, delay the absorption of liquids. Upon this trough lay the blocks, of which one was fixed, the other movable. They served to hold the plates that sink into the liquid, and to regulate at pleasure their distance from each other. The plates equal in area to the cross section of the trough, were secured to copper plates, which were made fast to the blocks, and put in connection with the termini of the electromotor.

For a battery, the constant coal and zinc pairs of Bunsen, from one to several in connection, were employed. The intensity of the current was measured with an exceedingly accurately constructed Weber's galvanometer. To maintain a current of unchanging strength, a Wheatstone's Regulator was used. The wire of the latter was of German silver, whose conducting power, Prof. Buff had ascertained to be 12·4014 times that of chemically pure silver. The diameter of the wire was 1·5042 millimeter, and the length of a winding of the Regulator 0·751 millimeter.

The temperature of the liquid proved was from 18° to 20° C. (64·°4 to 68° Fah.)

The course of experiment was this. The two plates were placed in the partly or wholly filled trough exactly parallel to each other, first at a distance of 2·5 centimeter from each other, when the circle was closed, and with the aid of the Regulator the needle of the galvanometer directed upon a particular degree. Hereupon the distance of the two plates was increased by carrying back the movable one, and the amount of German silver

* Lenz, Poggendorff's Annalen, Bd. xliv, s. 349.

wire observed which must be taken out of the circuit, to bring the needle to its first position. It is obvious that the increase of the fluid mass occasioned precisely the same resistance as the unwound German silver wire, and this, entirely independent of the influence of polarization.

The following numbers are the average of at least three, but generally of a larger number of nearly coinciding observations.

At first it appeared to me of importance to ascertain approximatively the influence of the intensity of the current upon the conducting power. To this end the trough was filled to 0·0275 millimeter with diluted sulphuric acid of 1·10 spec. grav. I obtained by—

Variation of the needle.	Resistance in windings of German silver wire.	
	For the first 2·5 cent	For the following 2·5 cent.
10°	32·44	20·67
20	20·30	21·25
30	10·74	20·00

The resistance of the first 2·5 cent. liquid, which embraces the influence of polarization, shows it to be variable with the strength of the current, while, as soon as this influence becomes eliminated, the resistance is the same for different intensities of current. Similar experiments with other liquids, as chlorid of sodium, sulphate of copper and others, gave precisely the same result. It appeared to me therefore, sufficient to ascertain with the greatest accuracy, the resistance of the most of these liquids, only for one intensity of the electric current. In order, then, to oppose the variability occasioned by polarization in the course of a series of experiments, this was maintained with the greatest care. In all the following statements of the length of the layer of liquid, the first 2·5 cent. which includes the resistance of the polarization are withdrawn.

It is assumed that the resistance presented by fluids is, as is the case with solid conductors, directly as the length and inversely as the section. My experiments confirm the assumption.

I content myself with the presentation of only a single series of experiments, which were made with the sulphuric acid of the previous experiment.

Length of layer of Fluid. Centimeter.	Resistance in windings of German silver wires.	
	Observed.	Calculated upon length of 5· cent.
25·	20·67	4·134
12·5	10·75	4·300
7·5	6·98	4·654
5·0	4·25	4·250
2·5	2·11	4·220
	Medium value,	4·311

The trough was filled with acid to a depth of 0·0275 meter. As the depth of fluid was here increased to 0·048 meter, the resistance for 5· cent. length was equal to 2·56 windings. But 0·0275 : 0·048 nearly as 2·56 : 4·311.

We derive from the above a perfectly clear conception of the resistance to conduction, which a liquid of definite chemical constitution presents, and can bring it in calculation, when but for a single length and for a single section an accurate admeasurement has been made.

The results at which I have arrived in the different fluids examined by me, are conveniently arranged in the following table. The numbers in the columns below need no farther discussion.

I have only to add that common platinum plates were employed in the liquids; only, in copper solutions copper plates, and in the zinc solutions zinc plates, were used to lessen the polarization. The solutions employed were chemically pure.

Name and property of liquid.	Depth of liquid in trough.	Resistance in windings of Regulator.	Resistance in windings of German silver, = 1.
		For 5 centim. length of the liquid.	
Sulphuric acid of 1·10 sp. gr.	0·0275 met.	4·311	75673
" " 1·15 " "	0·0275	3·680	67770
" " 1·20 " "	0·0275	3·202	56180
" " 1·24 —	0·0275	3·200	56180
" " 1·30	0·0275	3·200	56180
" " 1·40	0·0275	4·700	82520
Sulphate of zinc solution, of which 100 cc. contained 7·287 grm., ZnO, SO_3, HO,	0·275	108·00	1896000*
4·175 grm. ZnO, SO_3, HO,	0·275	151·70	2663400*
Sulphate of copper solution, of which 100 cc. contained 15·093, CuO, SO_3,	0·0275	55·38	972320
7·547 " " . .	0·0275	80·32	1410200
		For 2·5 cent. length of liquid.	
Chlorid of sodium solution :—			
27·6 grm. in 500 cc. water, .	0·023	19·65	577100
21·3 " " " .	0·023	26·20	769460
Twofold dilution, . . .	0·046	25·336	1488200
Fourfold, " . . .	0·046	44·72	2750560
Chlorid of potassium solution :—			
27·6 grm. in 500 cc. water, .	0·023	19·68	578000
Twofold dilution, . . .	0·046	18·79	1103700
Fourfold, " . . .	0·046	34·16	2006500
Chlorid of barium solution :—			
38·46 grm. Bad in 500 cc. water,	0·023	37·50	1101300
Twofold dilution, . . .	0·046	37·07	
Chlorid of strontium solution :—			
29·30 gr. SbCl in 500 cc. water,	0·023	26·56	780100
Chlorid of calcium, solution of 1·04 sp. gr.,	0·023	22·90	672560
Chlorid of magnesium solution, 1·04 sp. gr.,	0·023	22·89	672560
Chlorid of zinc solution, 1·04 sp. gr.,	0·023	37·20	1092500

* These results for the resistance of the solution of sulphate of zinc, I can permit to be recorded only as approximations; for while the zinc precipitate from the liquid arranged itself, partly in erect needles constantly elongating, there appeared in the progress of each experiment, a slow diminution of the resistance of the foremost layer.

ART. VI.—*Fossil Footprints of a New Species of Quadruped;* by JAMES DEANE.

I HAVE hitherto described in the pages of this Journal, certain quadrupedal footprints from the new red sandstone of Connecticut River, the origin of which may be referred with probability, to animals represented by the Batrachian order of existing reptiles. These impressions are of diversified character, and indicate three distinct family types or groups, as explained in a former number of this Journal.*

To the third group, I have now to add a second or new species; it is represented by the annexed wood-cut, which is of natural size. It closely resembles except in size, the species described in vol. iii, ii ser., p. 70, and it is possible that the impressions were produced by a young individual.

This elegant example was recently discovered at Turner's Falls. The slab contains seven pairs of impressions, three of which are represented by the drawing. It will be apparent that the animal was of diminutive size and that it advanced by regular strides and sunk deep at each step. The regularity and number of the imprints, give a beautiful appearance to the fossil, yet the feet are not individually so perfect as to render their anatomical configuration clear. There appear howev-

* Vol. iii, ii ser., p. 74.

er to be four toes and the tarsus. Feet divergent. I think the impressions may with propriety be referred to some member of the tailed or Salamandrian family of Batrachians. But until we get the perfect impression of the feet as we do in some ornithic examples, there are no true data for comparison with the feet of existing genera.

Several new species of ornithic impressions have been disclosed at Turner's Falls, during the past season, which may at some future time form the subject of a distinct notice.

Greenfield, (Mass.,) Oct. 7, 1847.

Art. VII.—*On the Depth and Saltness of the Ocean.*

(From the Proceedings of the Ninth Annual Meeting of the American Association of Geologists and Naturalists, at Boston, September, 1847.)

Captain Wilkes, U.S.N., to whom these subjects were referred at the last meeting of the Association, said that he found it impossible to make a written report upon subjects of so great interest as were embraced in the enquiry referred to him: from the little attention that had as yet been given to enquiries on these subjects, but few facts had been elicited; he should therefore content himself by stating to the Association what had been done, although it was comparatively little, with the hope that the Association would be induced to turn their attention to the subject as one of great interest for future enquiry. He stated that with the depth of the ocean there were connected many interesting subjects of enquiry; among them, its actual depth, its mean temperature and density, the penetration of solar light, submarine currents, and the saltness and specific gravity of sea-water.

Although experiments to ascertain the depth of the ocean have been frequently made, we are as yet ignorant of its maximum depth, and we continue to be satisfied with the conjectures and the results obtained from theory. These as is well known, vary in the limit of depth from five to eight miles.

The greatest depth to which the ocean has been penetrated is 4600 fathoms, or 27600 feet; no bottom was obtained; this was the result of an experiment by Capt. Ross in lat. 15° S. and 23° W. long. Several experiments have been made at other points, and some with success, bottom being obtained in apparent mid-ocean in between 12,000 and 18,000 feet. The ocean has been penetrated in too few places to afford any satisfactory or decisive results upon so interesting a subject; and considering the vast space of our globe occupied by the great ocean, it cannot but strike every one what a wide field is open for investigation and

experiment, and how many interesting geological results may be elicited and are connected with these experiments; sufficient facts have been developed, to prove that the inequalities of the level of the ocean's bed, are much more remarkable than those of the land.

It may excite surprise that we should know so little on this point: navigators, to whom this interesting enquiry properly belongs, have troubled themselves little about it, unless it was in some way connected with the safety of their voyages. The existence of discolored water has alone induced them to cast the deep sea lead. There is however some excuse to be made, for though in theory the depth is easily to be arrived at, yet to obtain it practically is exceedingly troublesome, requiring much time as well as favorable opportunities.

The mode still practiced is the ordinary lead line. Substitutes for this have been attempted; many of them are ingenious and some useful, but they do not obviate the difficulties, although they give greater accuracy in the results. Few are aware that it requires from two to three hours for a well appointed vessel to make a sounding to the depth of 1500 or 2000 fathoms, for which opportunities seldom occur: calms or light winds, and a smooth sea, are requisite.

The mode of sounding practiced of late by several British officers to obtain the actual depth, is by attaching a weight of several hundred pounds to a small cord or spun yarn wound on a reel, which is carried off as the weight descends; on reaching the bottom it is pulled taut and the length ascertained; the cord being too weak to lift the weight, both are lost,—consequently, the experiments are expensive as well as inconvenient to make; the time required for the experiments even in this way, is half an hour for the descent of the weight; the line in these cases instead of being used from the ship, is lowered from a boat to avoid the drift of the vessel, which is very considerable in the time the weight is descending; this renders the experiment more satisfactory and correct. It will thus be seen that it is out of the power of an ordinary vessel to make the experiments; in order that this interesting enquiry may advance without these difficulties, it becomes necessary that some new mode of sounding be adopted whereby both the time may be lessened and the opportunities multiplied. It has been suggested to obtain an echo from the bed of the ocean by the explosion of a shell just beneath the surface, the depth to be measured through the propagation of reflected sound. The mode which appears to me more effective, is by the time of descent and the direct waves of sound from an explosion at the bottom, which might be accomplished by charging the shell with some of the explosive compounds; the momentum acquired by the descent of the shell would cause explosion on striking the

bottom; the great difficulty which seems to present itself, is the preservation of the charge of the shell from damage by the enormous pressure to which it would be subjected in its descent: such experiments would naturally lead to interesting investigations relative to the descent and movement of bodies through water, and result in establishing the laws to which they are subject, an enquiry that has been but partially carried out.

Although the experiments to ascertain the depth of the ocean have been few and without any regular order, yet they afford evidence and prepare us for some interesting results in future. Among them is one that the great depressions or submarine valleys run nearly at right angles to the great mountain chains of this continent; for instance we are led to believe that at the equator there is a depression to nearly the 5th parallel of south latitude, where a ridge occurs; at the 15th parallel we find another depression; 10° farther south we have another ridge; it again deepens and rises twice towards the polar circle. These are it is true but conjectures derived from detached and isolated trials, and may not be confirmed by future and well conducted experiments; they are only adduced here to show the field open to investigation, and to prompt to measures that the Association may deem necessary to secure results. A well directed series of experiments even with the imperfect means we now have, could not fail to make us acquainted with the submarine valleys and ridges which traverse our globe, and in time give us sections of the beds of the ocean. There are many opportunities enjoyed by the commanders of our men-of-war, that might be taken advantage of whilst proceeding to and returning from the different foreign stations; and I make no doubt that these would be readily authorized by the distinguished gentleman who now presides over the naval service. All that is required is for this Association to take some measures to forward this subject, and to point out positions at which it would be most desirable to obtain results. If those who have the direction of foreign navies could be induced to join, we should be enabled in a very few years to exhibit complete sections of the oceans and seas, and full investigations into the phenomena connected with the ocean.

Although the actual depth of the ocean has not yet been successfully determined, the numerous trials have resulted in determining satisfactorily its mean temperature and density. Its mean temperature is nearly 39°·5,* and according to Capt. Ross's exper-

* I am aware that several distinguished navigators and others have reported different results; among them Mr. Lenz even places it down to 36° and 37°, which they report having met with in the tropics at nearly 1000 fathoms; from our own experiments and from those of many others, I cannot but believe that some error has occurred; I am well satisfied that so low a temperature will not be obtained within the tropics at any depth, unless through the agency of submarine currents.

iments, the zone of mean temperature lies between the parallels of 54° and 60° of south lat., not only at the surface, but to as great a depth as the ocean has been penetrated. Future trials will in all probability reduce it to narrower limits: its position in the northern hemisphere remains yet to be ascertained. This mean temperature is met with both within the polar circles and in proceeding towards the equator. In the higher latitudes above 60°, the ocean in descending increases in temperature until it arrives at its mean point; while proceeding towards the equator it decreases from the surface downwards; this decrease beyond the tropical circle, is about twenty-three fathoms for every degree of latitude. Within the tropics it is 1° for every thirteen fathoms of depth, until 400 fathoms, after which it requires a descent of from 200 to 300 fathoms to effect a like change.

From the observations of Admiral D'Urville, it would appear that the waters of the Mediterranean do not follow the rate of descent of the Atlantic and Pacific Oceans. He estimated the mean temperature of that sea below 200 fathoms, at 55°, and this from the fact of his having obtained that temperature at the depth of 1000 fathoms. If this be so, it leads to an interesting enquiry, as to whether it may not be in consequence of the vast internal fires that are known to prevail in the countries that surround it.

The penetrations of solar light or the depth at which it becomes totally absorbed, is another subject which claimed particular attention during the cruise of the Exploring Expedition. The mode of obtaining results was to let down a pot, bottom upwards, painted white, some eighteen inches in diameter, by the deep sea line until it was lost sight of, noting the depth at which it disappeared, and then again its reappearance, the mean being taken for the result; these seldom differed more than a fathom; the eye was placed five feet above the surface in the direction with the line by which the pot was held. It would appear at first that the depth at which an object could be seen would depend upon the intensity as well as the angle at which the rays of light fell upon the surface of the ocean. They undoubtedly have some effect, but seldom made a greater difference than 1½ fathoms. Under different latitudes and in different temperatures of the water, the anomalies far exceeded this, and were indeed too great not to excite enquiry and call attention to other causes. There is little doubt that the great cause of the variation noticed in the temperature of the waters, affected in a great degree the transmission of the rays of light, or their absorption. In water at the temperature of 78° to 80°, the white object described was discernible at a depth of 180 feet, while in water at 36°, it was lost sight of at 40 feet. The object gradually diminished until it disappeared. Trials were made frequently and at every hour in

the day, from early in the morning till late in the evening, the altitude of the sun being measured at each trial. These experiments took place when the sea was nearly calm and quite smooth; the greatest depth at which the object could be perceived, was 30 fathoms, or 180 feet.

The next phenomenon connected with the depth of the ocean is submarine currents; they exist in various parts of the ocean where they have been traced, and are indicated by their low temperature; their actual limits as to depth have not as yet been determined, but they are found to prevail at from 5 to 600 feet below the surface; they are so immediately connected with the dynamics of the ocean, that the investigation into their direction and causes has long obtained attention.

The saltness and specific gravity of the sea have been frequent subjects of enquiry. The results of the Expedition will throw much light upon this subject. The specimens of sea-water obtained in different latitudes were, on the return of the Expedition, placed in the hands of one of our most distinguished associates, Dr. C. T. Jackson of Boston, whose ability as a chemist is well known to the country; he has analyzed them, and as it will yet be some time before the full results can be published in the volumes of the Expedition, the Association will be gratified by a knowledge of his method of analyzing, as well as by a few of the results.

Method of Analysis.—"The specific gravity of the waters was taken in a small flask with a neck of about ¼ inch in diameter. A quantity of the water equal to 1000 grains of distilled water, was evaporated slowly to dryness in a platina capsule, carrying the heat to 300° F., then weighed the contents by counterpoising. Dissolved out the muriates of lime and magnesia by absolute alcohol—filtered, dried and weighed the insoluble part. The soluble part was evaporated in a counterpoised platina capsule and weighed—dissolved out in acidulated water and precipitated the lime by oxalate of ammonia—filtered, dried, ignited, adding a few drops of carbonate of ammonia and weighed, which gave the quantity of carbonate of lime, from which the calcium and chlorid of calcium was calculated. The magnesia was then precipitated by phosphate of soda and ammonia, filtered, dried, ignited and weighed, from the resulting biphosphate of magnesia, the quantity of chlorid of magnesium was calculated.

"The matter insoluble in absolute alcohol was dissolved in hot distilled water, and the part insoluble in water was ignited, dissolved in acid, filtered, and added to the aqueous solution. To this added ammonia which threw down the phosphates, filtered, dried, ignited and weighed. To the solution then added oxalate of ammonia to precipitate the lime—filtered, dried, ignited and weighed, from the carbonate was calculated the lime. To the

remaining solution phosphate of soda and ammonia was added, which threw down the magnesia—filtered, dried, ignited and weighed, from which calculated the magnesia.

"A separate quantity of the water was operated on for the sulphuric, carbonic acids and chlorine. To the water was added baryta solution which threw down the sulphuric and carbonic acids —filtered, washed slightly and rapidly, dried, ignited, adding a few drops of carbonate of ammonia and weighed, then dissolved in muriatic acid which dissolved the carbonate of baryta, leaving the sulphate—filtered, dried, ignited, and weighed; from the sulphate of baryta the sulphuric acid was calculated.

"Subtracting the weight of sulphate of baryta from the sum of the weights of the sulphate and carbonate, gives the quantity of carbonate, from which the carbonic acid is calculated. To the solution after separating the sulphuric and carbonic acids and the excess of baryta, a few drops of nitric acid were added, then nitrate of silver which threw down the chlorine—filtered, washing with acidulated water, dried and weighed, from the chlorid of silver the chlorine was calculated.

"The quantity of soda and sodium was found by subtracting the sum of the weights of the other ingredients from the whole weights of the dry salts obtained by the first evaporation. Four or five specimens of water were examined for iodine, bromine and potash, of which no traces were found.

"The filtering paper used was the fine white unsized India paper. Equal double filters were used throughout, burned separately in platina crucibles over the spirit lamp, and weighed against each other; for the greater part of the salts the filters were counterpoised previous to filtering.

"The water used was distilled in Bohemian glass retorts and was absolutely pure.

"All the tests and reagents were prepared in Dr. Jackson's laboratory and were proved to be pure before employing them in analysis.

"The balance used in taking specific gravities and for weighing the products of analysis was made by Chémin of Paris, Fr., and is sensible to the $\frac{1}{1\,0\,0\,0}$th of a grain."

All the tables comprising the analysis of the waters will be given in the volumes of the Expedition, the two following will show the ingredients of sea-water as determined by the above method by Dr. Jackson.

Analysis of water from the depth of 100 fathoms, in lat. 63° 18′ S., lon. 55 W.:—temperature at surface 31°; below 30°. March 4th, 1839.

Specific gravity of the water = 1·026; temperature 60°; bar. 30·05.

A quantity of water equal in bulk to 1000 grains of distilled water evaporated, gave,

Saline matter, ... =36·00 grains.

This saline matter analyzed, yielded,

Chlorine, ...	20·73	36 grains.
Sulphuric acid, ...	1·29	
Carbonic "	1·29	
Phosphoric "	0·06	
Soda and sodium, ...	10·12	
Magnesia, ...	1 64	
Lime, ...	0·83	
Oxyd iron, ...	trace	

Water from the depth of 450 fathoms:—temperatures at that depth 44°·5; temperatures of surface 74°; lat. 17° 54′ S., lon. 112° 53′ W. July 29, 1839.

Specific gravity =1·0275; temperature 60°; bar. 30·05.

A quantity of water equal in bulk to 1000 grains of distilled water evaporated, gave,

Saline matter . . . . . =37·9 grains.

This saline matter yielded,

Chlorine, ...	20·40
Sulphuric acid, ...	2·43
Carbonic "	0·68
Phosphoric "	0·09
Soda and sodium, ...	10·76
Magnesia, ...	2·48
Lime, ...	1·06
Oxyd iron, ...	trace
	37·90

Capt. Wilkes, before concluding, alluded to the results of the Exploring Expedition, and gave some account of the progress that was making in their publication. At the same time he presented for the inspection of the Association some three hundred proofs of the plates of Natural History, a part only of those now in the engravers' hands, which he trusted would prove of interest to the Association as showing not only the progress of the work under publication, but the advancement of American art. For the beautiful manner in which they were gotten up and executed, we were chiefly indebted to Mr. Drayton, one of the artists of the Expedition, who has charge of the department of publication, and to whose talents and exertions he felt great pleasure in making this acknowledgment, and expressing how much the Expedition, the country, and he himself, were indebted to him. Capt. Wilkes also gives strong hopes that the edition of the works of the Exploring Expedition will be enlarged, and he hoped that it would be in the power of all to obtain a complete copy of the work; at

present they were making every exertion which the ability of the country and due economy would permit, to forward it to completion. The Committee of Congress who have the publication in charge, have every desire to enlarge it; but they have deemed it proper that the whole work should be first completed, and then it could not be doubted but that the liberality of Congress would cause the publication to be extended, so as to place the whole within the means of every institution in the country.

Prof. Agassiz here took occasion to express his opinion of the Expedition, and spoke of the results in the highest terms. He bore testimony to the beauty as well as accuracy of the engravings, acknowledging that they were not surpassed by any that had hitherto appeared in Europe.

ART. VIII.—*On the Limit of Subdivision by Trituration and Solution, and the principles on which the limit may be indefinitely extended;* by B. F. JOSLIN, M.D., of New York.

IF any coarse and dry substance is triturated by itself, it will continue to be permanently divided and subdivided to a certain, but limited extent. For beyond that, the blow would either leave the parts so near each other, that they would instantly reunite by the power of the cohesive forces and again become one solid body, or would drive these newly separated parts against others or against each other, and effect their union by bringing them within the sphere of cohesion.

If a flint stone were pulverized in a mortar, it would at length become so fine, that some of the finest of these invisible flint stones would, after any farther division, be soon reunited. All that would be necessary for their reunion and the restoration of their previous hardness, would be, to bring the parts or their mutually attractive poles, as near to each other as they had been before their separation; for the strength of their cohesion depends on the degree of their proximity. The approximation and union of some of these smaller than microscopic pebbles, would be promoted by the pressure of the pestle: the same blows that severed some, would unite others, so that the average size of the parts would remain unchanged.

I have referred to poles, believing that the cohesion of all atoms and of all groups sufficiently small, depends on polarity and is a crystallizing force, and probably magnetism itself in its most elementary form. But similar principles apply to my theory of comminution and similar language may be employed, whether we regard the cohesive force as residing on all sides of the groups, or only at certain poles. For if a group were surrounded by ma-

ny others within its sphere of cohesion, some of their poles would be in a position favorable to union, and others be brought into that position by rotation, as would be the case with a multitude of small magnets thrown together promiscuously.

In experiments with the solar microscope, twelve or fifteen years since, I saw and exhibited to the Senior class of Union College, thousands of instances of rotation, attraction, and induction, in the crystals of camphor formed from the tincture placed on a small plate of mica and exposed to solar radiation. When the sky was very clear and the radiation intense, the phenomena became confused by the rapidity of the crystallization, and it was necessary to dilute the saturated tincture with about five times its bulk of alcohol, in order that these phenomena might be exhibited in all their distinctness and beauty. Thin clouds permitted the use of the undiluted tincture, and intermediate states of the sky required intermediate degrees of dilution. A description of these interesting phenomena was given in the "Report of the Regents of the University of the State of New York, for the year 1836," pp. 207 to 209, and an abstract in this Journal, vol. xxv. I here refer to them as evidence of the polarity of minute groups.

In resuming the consideration of pulverized flint, let us suppose the powder had attained such an extreme degree of fineness as can be given to it by a process which I shall describe, and let us suppose that it could be separated from other substances and subjected in mass to the blows of the pestle; the effect would be like that of pounding a quantity of clean leaden shot: we should stick them together in large masses. If we had a sufficient quantity of such a powder confined in a cylinder and pressed by a piston, we could probably unite it all into one flinty rock, perhaps defective in hardness at some points, from want of the requisite position of the poles.

I have taken an extreme case, in order to enable the reader more easily to conceive of the principle on which the limitation to comminution in the ordinary process of pulverization depends. The powder of any substance, pounded or rubbed by itself in a mortar, would attain a limit of fineness, beyond which its subdivision could not be carried by the combined labor of all mankind operating in the same way through all ages.

A sliding motion of the pestle enables us to go a little farther before we reach this limit, not only because it subjects small isolated masses more directly and efficiently to the dividing force, but because it allows fewer opportunities for the reuniting force of cohesion to come into play, by keeping the newly divided parts at a greater distance from others already divided. But in this mode of operating also, the limit will be as surely reached as in pounding. For when a certain degree of fineness has been effected by this rubbing process, the stratum of powder beneath the

pestle will either be so thin as to elude its dividing action, or so thick that the number of parts which are pressed against each other by its strokes and reunited, will equal the number divided by the same strokes. At this stage, the comminution will cease; and the trituration, ever so skillfully conducted, and carried on forever, could not reduce the powder to any greater degree of fineness.

Is there any way in which this limitation may be obviated, and the fineness of the powder indefinitely increased? Yes: it may be done by successive mixtures with some other substance, using thorough trituration after adding each portion. This method is of universal application; yet for the sake of convenience and precision, I shall assume particular substances and a particular proportion. Suppose a flint powder to be rendered as fine as it is possible to make it by rubbing it per se; and suppose one grain of this to be triturated with ninety-nine grains of ordinary loaf-sugar, or of the harder—and therefore better—non-medicinal substance, sugar of milk. Suppose, by means of stirring with a spoon or spatula, the flint powder be intimately mixed with the pulverized sugar, so as to be uniformly distributed through it, before the trituration is commenced. [This is not requisite in practice, but simplifies the investigation.] Then each of the microscopic flint stones is surrounded by ninety-nine times its weight of sugar, which keeps them at nearly five times their former distance from each other, as estimated from centre to centre. What is the consequence, if trituration be commenced under these circumstances? A new and far more minute division must result.

The sugar serves two purposes, viz. first, to divide the flint, and secondly, to keep it divided; it contributes both to effect and preserve the division. It serves the first of these purposes in more than one way. First, it aids division by mechanical collision, when driven against the flint by the pestle. It in this way aids the fracture; as the stroke of one body may often be made to break another though harder than itself. Thus a quartz pebble can be crushed between two large pieces of marble, and a still smaller one between two large pieces of sugar of milk. The advantage given by magnitude, suggests that the sugar employed will be more effectual if selected in a state coarser than that of the harder powder which it is employed to comminute. In later stages it will necessarily have this advantage. Secondly, the sugar may aid the division by its affinity, its attraction for the flint. Thus whilst some of the pieces of hard sugar are acting as hammers and wedges, and tending to separate an intermediate piece of flint into two pieces, other pieces of sugar, situated in the line in which the fragments of flint when divided tend to move, may by their affinity draw the fragments in the direction in which the other pieces of sugar push them, and thus both kinds of force conspire to effect their separation.

Having hitherto considered the direct agency, I now proceed to the indirect; viz. the promotion of farther division by keeping separate the parts already divided. The sugar favors comminution by keeping the pieces of flint at a distance from each other, and thus preventing that reunion which would be continually taking place in the parts of the pure flint powder pressed against each other by the pestle. The parts when once divided, are by the interposition of the sugar prevented from again coming within the sphere of mutual cohesion, until the subdivision has been carried to a much greater extent than would have been practicable in triturating the flint by itself.

A limit will, however, be ultimately reached, even under these circumstances. As the subdivision continues, the mutual distance of the pieces of flint diminishes, and some portions are ultimately brought again within the sphere of cohesion, and made to unite by the same strokes of the pestle which divide others. When the number united by each stroke equals the number divided by the same, the fineness can no longer be increased by continuing the friction.

The only way in which the fineness can be increased, is by another mixture. If a grain of this powder is mixed and triturated with ninety-nine grains of hard sugar, like that previously employed, a still more minute division of the flint is effected; but, for the same reasons as in the preceding case, we ultimately reach the limit, beyond which it is impossible to pass without a new mixture or dilution. By the continued repetition of operations similar to those above described, an inconceivable degree of comminution may be effected.

We may not be able to determine theoretically the number of subdivisions which are practicable at each stage. But if subdivision did not affect the intensity of cohesion, and if the division were already carried so far, that the magnitude of each piece was so small compared with the magnitude of its sphere of cohesion, as to produce no sensible influence in the estimate, then it would appear from the theory above given, that the maximum comminution at each stage would be in the ratio of one hundred to unity. So that flint, silex, gold, mercury, or any other substance prepared in this way with sugar or saccharum lactis—or some other suitable substance—would, at each succeeding stage of the process, be divided into parts, all of which would be one hundred times as numerous, and each of which would be the one hundredth part as large as the parts in the preceding stage. This increase in the number, however, supposes that every grain of the preceding one hundred is subjected to a similar operation. If, as before supposed, only one grain at each stage is taken from the hundred and subjected to this operation, then the parts of each trituration will be equally numerous, but increase in fineness at each stage

in the ratio of one hundred to one; and a grain of the thirtieth trituration of gold would contain as many minute pieces as a grain of the third trituration.

But I am convinced that the intensity of some properties of substances is greatly increased by comminution. If the sphere of cohesion is thus increased, the maximum comminution will fall below the above estimate. I believe that in practice the comminution will fall below it, not only for the above reason, but also because the trituration, though continued sufficiently long to bring most of the parts to the maximum size, will be discontinued before every part is equally reduced.

Hence microscopic observations are liable to lead to erroneous conclusions. Dr. Mayerhofer has seen scores of millions of pieces of metal in a single grain of the sugar with which it had been triturated to form the third trituration. The number varied with different metals. From the considerations which I have above stated, as well as from others, I am convinced that the number of invisible pieces far exceeded the number of visible ones. Those only were seen which had escaped the full effect of the dividing forces. The minimum groups in the third trituration are not objects of microscopic vision. From the wide range of magnitude in the visible pieces, as well as from the appearance, on close inspection, of pieces at first invisible, Dr. M. justly concluded, that in the first trituration of precipitated gold, "the metal is divided into particles so small as to be invisible under a glass magnifying 14,000 times." He "examined the fourth trituration by a power magnifying 90,000 times, and it was evident that the diminution of the particles progressively increased; the smallest gold molecules appeared yellow, and the metallic lustre was not to be mistaken." The diminution here refers to the visible ones. As the conclusions which I have drawn in regard to the facility of reunion, the limit of comminution, and the intensity of properties, refer to those more numerous groups which are so small as to be invisible by the most powerful microscope, it would be impossible either to establish or refute them by microscopic observations.

The above method of trituration has great advantages for effecting a minute division of substances. I have shown, that in order to triturate a substance to powder of a certain degree of fineness, it is necessary to mix it with a sufficient quantity of some other substance; and that the requisite quantity of this admixture increases with the fineness required. Such a degree of fineness can be specified, as would render the labor of comminuting a single grain impracticable, even if the requisite amount of material for the admixture could be obtained. The labor of the whole human race operating through all ages since the creation of man, could not thoroughly triturate a single grain of one substance with a decillion grains of any other substance. Yet the

same degree of fineness as would be effected by such an operation may be effected by one man in thirty hours, and with scarcely three thousand grains of auxiliary material. If we suppose him to commence with one grain of the substance to be comminuted, and allot one hour to each of the thirty stages, the resulting powder would contain a portion of the original grain, in a state of fineness equal to that in which the whole grain would have existed in a decillion grains equally well triturated.

The above theory is original; but this process of trituration is not. Most persons who have practiced it, have not considered the only direct object of it to be comminution; and if any have, they have not explained, on physical principles, the mode in which it is effected, nor the limit which we encounter by the ordinary process, nor the peculiar advantages of this process in avoiding that limit.

I shall not here state particularly the effect and ultimate object of the comminution effected by the above process. In my opinion it must develop a species of magnetism, and the minutest pieces thus obtained must be intensely magnetic. As a branch of physical inquiry, this subject has especial interest at the present time, when the attention of philosophers is becoming more and more directed to molecular forces, and the peculiar properties of small masses. The recent experiments of Sir G. C. Haughton have afforded new evidences of the identity of molecular magnetism and cohesion, and new proofs that all bodies are magnetic when they are rendered sufficiently small.* What intensity of magnetism may not be expected in bodies as minute as those which can be suspended fifty or a hundred miles above the earth's surface, in air so rarified as to be incapable of reflecting any sensible quantity of solar light! I believe this intensity to be far more than sufficient to compensate for the reduction of the quantity of ponderable material, and to be adequate to the production of the most brilliant aurora borealis. In this case there is probably a crystallization, a change from the fluid or aeriform state to that of minute solids, whose magnetism ultimately becomes latent after aggregation in larger masses.

I believe it to be a general law of nature, that certain properties possessed by small groups of molecules, are marked or rendered latent by the proximity of a sufficient number of similar groups; and that, conversely, properties or powers are developed by the division of substances.

It would seem that bodies rendered so inconceivably minute as they can be by the process of trituration above described, must possess a most intense magnetic state, although their circumstances are evidently such as to preclude the application of

* Lond. and Edin. Phil. Jour., for June, 1847.

the ordinary tests. As the examination of any known mode of testing the power of such preparations would involve physical and professional considerations, I shall do nothing more than submit the mechanical explanation of the comminuting process to the consideration of natural philosophers, trusting that they will consider the subject interesting as a branch of physical investigation.

Similar principles are applicable to *subdivision by solution.*

It is generally believed, that the simple solution of a substance effects the minutest division of it which is practicable. In calling in question the correctness of this notion, I am aware of the strength of the prejudices to be encountered—prejudices both of the senses and intellect. For deciding such a point, there is no adequate delicacy in human vision nor in the instruments of physical research; nor is the human mind so constituted, as to be capable of any adequate conception of the minuteness of ultimate atoms, or of the infinite diversity of magnitude existing among infinitesimals.

The following are the views which I take of solution, and which I am desirous of submitting to the consideration of natural philosophers. In a saturated aqueous solution of any salt, I consider the molecules of the salt as existing in hard solid groups or masses of the salt, suspended at equal distances in the water, which exceeds the salt in quantity. Each mass of salt consists of innumerable particles. It is impossible to make these groups smaller, either by the affinity of the water or by any mechanical force, as long as the quantity of water remains the same. If they were sundered, they would instantly reunite. For, any division of the solids into smaller groups would diminish their mutual distance, and consequently increase their mutual attraction; whilst the quantity of water which surrounds each mass is diminished in quantity, and hence possesses less attractive force for resisting the reunion of the solids, than it had when they were in larger masses; even then this affinity was but just sufficient to keep them separate. Therefore any division would be followed by instantaneous reunion, both on account of an increase in the cohesive forces, and a diminution of affinity. The ultimate molecules are not separately invested with the water, but united in hard and complex masses, which cannot remain suspended within a given mutual distance.

How can this limitation be obviated, and the size of these complex molecules be progressively and indefinitely diminished? This may be effected by successive dilutions. To select the same proportion as in trituration, suppose one drop of the saturated solution to be put into ninety-nine drops of water. This water exerts its affinity as an antagonist to the cohesion of the solid groups of salt, and effects their dismemberment to a far

greater extent than was practicable in the saturated solution. Brisk agitation favors uniform diffusion and rapid dismemberment, and more promptly in a vessel but partly filled. But the process of disintegration commences instantly, before the diffusion is complete. To simplify the investigation, let us suppose the drop to be uniformly diffused before any disintegration of the groups commences. The groups would be at nearly five times their original distance, and each mass or group of salt would be surrounded by one hundred times as much water as in the saturated solution. This state of things could not remain a moment; especially if the disruptive power of the affinity of this increased quantity of water, were aided by a mechanical succussion, as strong as that to which the saturated solution had been subjected. For the equilibrium, before existing between cohesion and affinity, will be disturbed by that increase of the latter which results from the increase of the liquid; and the suspended solids will each be sundered into numerous smaller solids. But the salt is not divided into its smallest particles; nor could it be by the most violent succussion. The vibrations caused by jars, transiently increase the distance of some particles of each group, and approximate them to the liquid, and thus give affinity a preponderance over cohesion. In this way succussion aids division. But to carry division by this means beyond a certain point, effects no permanent change; as the particles will instantly reunite by the preponderance of cohesion over affinity.

If a drop of this solution is shaken with ninety-nine drops of water, a new subdivision of the molecules takes place, on the same principle. By repeating this process, the groups may be rendered inconceivably small, and this magnitude progressively and indefinitely diminished. I doubt whether those who have practised it have understood its immediate object, or the mode in which it is attained.

New York, July 23d, 1847.

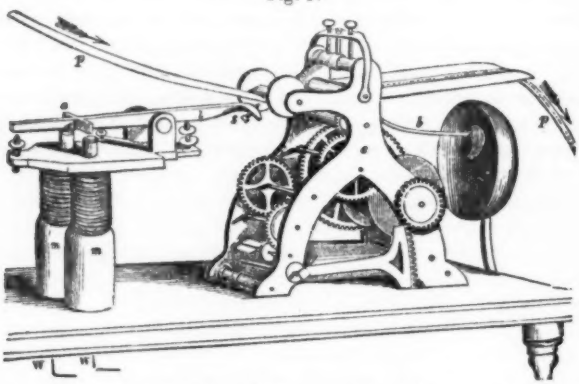
Art. IX.—*On the Electric Telegraph of Prof. Morse;* by Charles T. Chester.

Presuming upon the reader's acquaintance with the general principles of modern electric telegraphs, a brief review of them as they relate to Professor Morse's system will suffice. Its elements, the battery, electro-magnets, with the circuit of connecting wire, are becoming in their theoretical relations a part of popular knowledge. Their practical operation and those peculiarities of the American telegraph which have given it the prominence it enjoys, alone need an explanation. It is one of those inventions

whose simplicity is more wonderful than their effects; its excellence is its easy practicability, requiring but small capital either mental or pecuniary.

For a considerable period three lines have been in operation. Although they have failed to realize the sanguine expectations of the public, they have already rendered themselves indispensable to the business community. This apparent want of success does not detract from the excellence of the invention, as it has arisen from the inadequacy of the *structures* to supply the wants of the public. The invention, in its application, must like steam pass through stages of progress before it secures perfect public confidence. The lines to which I refer connect New York with Washington, Boston and Buffalo. All have been built with limited capital and experience, and all are imperfect and liable to accident. Hence there is never a positive certainty of communicating between any two points at any given time. If there were, and if the assurance continued for any length of time, experience proves that four times the number of wires and operatives would be scarce sufficient to dispose of the accumulation of business. For the full understanding of the economy of our telegraph, its advantages, practicability, and the obstacles and difficulties which have hitherto rendered it unreliable, a brief description of the apparatus in its application seems necessary, even though it be already familiar to some readers.

Fig. 1.



The accompanying figure (1) presents a view of the essentials of the "register," the recorder of the telegraph character. *m m* represents its main feature, the electro-magnet, whose armature in its alternate attraction and withdrawal gives motion to the lever *l*, of which it is a part. The other end of the lever carries with corresponding movement the steel point *s*, which (accurately corresponding with a groove in the roller) indents at each upward

stroke the paper, kept running with uniform motion above it. The *attraction* of this armature is due to the magnetism induced in *m m*, by the current passing through a circuit, consisting of a distant battery, the helices *m m*, and two conducting media continuing from w w to the battery poles—when this circuit is broken and the magnetism discharged from *m m*, a spring withdraws the armature. Now were the wire composing one part of this circuit broken in any part, and its ends repeatedly brought into contact, the armature would vibrate in precise accordance with these motions. This breaking and closing is accomplished by the key, (fig. 3, K,) the pen of the telegraph, whose operation is obvious: as it is depressed, so is the armature, each at the same instant, practically irrespective of the length of the circuit. Hence, a uniform motion being given to the paper, the key being kept down, the armature depressed, and the pen raised, a continuous line is impressed on the paper. If the key be thrice quickly depressed, three dots are in like manner impressed. An alphabet of combinations of dots and lines is thus easily produced from the dexterous manipulations of the key. The sole use of the wheel-work represented in the figure, is to give the paper a steady onward motion. The wheels are driven by a weight regulated by a fly, and liberated or stopped by a "break" originally acted upon by the pen lever, now controlled by the operator's hand. This "break," ingeniously releasing the clock-work during the motion of the lever, has with the bell been dismissed as a neat contrivance, whose utility the telegraphic business has not yet sanctioned.

Every variety and change, preserving the original idea and relation of electro-magnet and pen lever, has been tried in the construction of "registers." In some the levers are perpendicular, in others horizontal, while in one form, a shaft playing horizontally through a tube carries, at one end the pen, at the other the armature. But of these instruments the least complicated are preferred, so accurately constructed as to give the paper a perfectly uniform and rectilinear motion, allowing of its being repeatedly indented with the telegraph characters in parallel lines,* and so adjusted with reference to the lever that no accident can displace the steel point from its appropriate groove.

The register, thus briefly described, with the battery and conducting wires, forms the sum of a popular description of Morse's telegraph. A clear idea of their relations is enough to convince one of the beautiful simplicity of the invention, nor is it improbable that such an application of the electro-magnet had often

* This is a very essential requisite of a good register, and none but the most carefully constructed possess it. "Paper guides" embrace the slip before it meets the rollers, and being adjustable to the right or left, direct the course of the paper with such accuracy, that it may be rewritten fifteen times in parallel lines. The instrument represented here does not exhibit them.

suggested itself to electricians. The arrangement described is however entirely impracticable through long distances, and a certain combination of circuits, requiring the aid of another instrument, becomes necessary. It is on the exclusive use of this instrument and this combination, that the value of the Morse patent is based. The "receiving magnet" is simple in construction and effect. Fig. 2 represents one form of it. The electric fluid, attenuated, as it were, in the great extent of metallic conductor it traverses, would not perceptibly affect the magnet described as the foundation of the register, and this though the circuit may be comparatively short (say thirty miles), and the battery fresh and extensive. Not only would the magnetism developed be insufficient to perform the mechanical operation of indenting the paper, but with the most careful adjustment the armature would be scarcely moved. To render available this attenuated current, the receiving magnet is interposed, differing from ordinary electro-magnets in the great length and fineness of its helix, 3000 feet of the finest covered wire being no uncommon length. As the diameter of these helices is but an inch and a half, each of the numerous coils is brought within inducing distance from the soft iron, which thus becomes a tolerably vigorous magnet, although the inducing current may be extremely feeble. The armature of this magnet is attached to a lever susceptible of delicate vibration and adjustment, an adjustment often rendered constantly necessary from the inconstant power of the current. The immediate use of this little instrument is the breaking and closing of a circuit, consisting of the register magnet, a small battery, with sufficient wire to con-

Fig. 2.

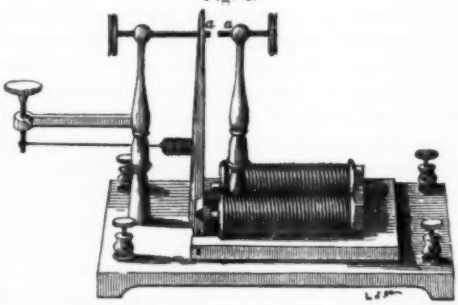
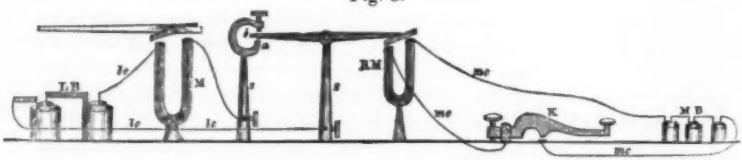


Fig. 3.



nect. Fig. 3 represents this arrangement and the relations of the magnets, batteries and circuits; RM representing the small magnet, *mc* the main circuit of indefinite extent, MB the distant battery, K the key which breaks and closes this extended circuit;

lc and LB represent the *local circuit* and battery, M the helices of the register magnet included in this circuit, which, as the standards *s*, *s*, are metallic, is broken only at the points *a*, *b*. Now the least possible space between these *points* effectually interrupts the current, and as they are covered with platinum, a very slight contact is sufficient to establish the connection. The little instrument is so delicately adjustable, that often when the breath could stop the vibrations of the lever, the circuit is broken and closed with certainty and regularity. The points are carefully kept free from dust, and the lever is adjusted by the elasticity of a spiral spring with its silk thread attachment. Very much of the operator's skill depends upon his management of this adjustment.

In the economy of our telegraph the battery is an interesting and important feature; in its employment as the motive power of the telegraph it has shewn capabilities which have surprised the most thoroughly scientific. The power now employed is about one-thirtieth of the original estimation. Grove's was the arrangement originally adopted, and it answers its purpose so admirably that it is almost universally retained. The objections to its use were the expense and offensiveness of nitric acid; a brief description of its economy will shew that these objections have no weight. The battery as an auxiliary to a business enterprise, differs essentially from the same agent in the laboratory. The zincs are cast with great care, and are in weight about two pounds each—the platinum member is substantial and valuable. Ordinary nitric acid is used for the porous cells—but in the best arranged batteries the diluted sulphuric acid is saturated with sulphate of soda with very great advantage and economy; not only is local action almost entirely prevented by this expedient, but reamalgamation is almost unnecessary. A little brushing of the surface of the zinc each night being all sufficient. So great a resistance to the free passage of the current in the main circuit is afforded by the great length of the conductors, that in the main battery scarce any save local action is perceptible, an assertion sustained by the fact that the battery charged as above, requires, if separated each night, fresh acids, but once in five or six weeks. Smee's battery, an arrangement so remarkable for its small local action, has afforded a uniform current for two weeks without separation.

The numerical extent of the series seems principally to give efficacy to the battery. It has worked competently with acids reduced almost to water and with metals scarcely immersed. Eighteen members of Smee's battery whose plates exposed but a square inch of surface, have worked competently through eighty miles; a single member, that might be contained in a thimble, through six miles. Of Grove's battery, a series of thirty is the average number for 150 miles of wire. The acids—of the "local battery"—require a daily replenishment.

A description of the out-door arrangements of the telegraph would seem superfluous—but a few particulars may possess some interest. The use of poles for the support of the wire is in th s country universal. These poles vary in size with the resources of the company—the standard being thirty feet in height, buried five feet in the earth, and having a diameter of six inches at least at the smaller extremity. The copper wire that has been heretofore used, weighing from 80 to 100 pounds per mile, is now universally displaced by iron wire of a weight of 300 to 330 pounds per mile. This is single or twisted, unprotected or galvanized. The advantages of the protecting coat are counterbalanced by loss of pliability and toughness; and good iron having withstood the test for years, the naked wire is generally preferred. Its cost is about 6 to 10 cents per pound.

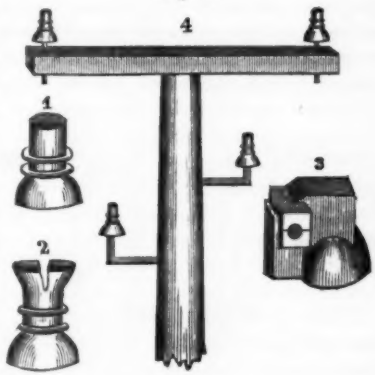
Among the elements of simplicity that give character and practicability to the American telegraph, is the use of the ground as return conductor. In the imperfect state of our original structures, the invention would have been almost unavailable but for this facility, as it has been found very difficult to keep two wires separated through any great distance, for any length of time. The use of the ground renders only one insulated wire necessary. The ground thus used proves moreover, a better conductor than wire; it requires less battery to produce equal magnetic effects, and when the choice of conductors is given, the current seems to prefer the heterogeneous to the homogeneous circuit. Communication with the ground is very easily established. A gas pipe in cities—a metallic plate buried in the ground or immersed in a well or river accomplishes this end. A few feet of wire thrown into a stream of water will establish the connection. If a wire, as fine as a hair, leading from the conducting wire as it crossed a river, were immersed in the stream, the interruption to communication would be as effectual as if the conductors were broken, the current from either battery would be returned.

In the economy of the telegraph, there is no more important requisite than careful insulation. A solution of the perplexities and difficulties that have opposed the successful working of lines, will shew the importance of insulation to be absolute. To attain it, several methods have been tried, generally varying in excellence with the expense. Experiments on various lines have proved the best available non-conductors to be imperfect.

With a view of protecting as much as possible the fragile insulator, the wire is supported from it in various ways. It has been usually belayed to glass "caps" shaped like those in fig. 4, either supporting the wire from their side (1) or sustaining it (2) in the groove. These caps fit over wooden or iron pins. In some cases two blocks of glass are dovetailed to each other in such a manner as to allow a central opening for the wire. In

other words, the wire at the point of insulation is imbedded in a glass parallelopiped. The glass in its turn is protected and surrounded by wood, and the wire slides through the glass generally without fastening. One of the latest plans of insulation, to be employed on the line from Troy to Montreal, makes use of these glass blocks, fitted immovably in a cast iron cap, the cap again insulated from the supporting peg by a heavy glass tube (3). The caps, of whatever form, are either upon cross-bars or supported by iron staples driven into the post (4), the latter method now prevails.

Fig. 4.

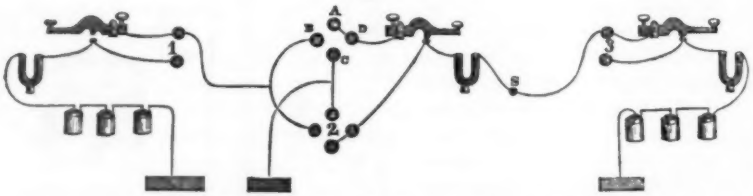


Such being the general construction of our lines, a few words as to their general business arrangements may not be inappropriate, as explanatory of their uses, capabilities, and the obstacles they have had to encounter. Each line has its termini generally giving name to the company that owns and governs it. Intermediate, are "stations" varying in number and importance with the length of the line. It matters not how many of these stations are interposed, provided the arrangements for the introduction of the wire at each secure its insulation. No perceptible difference in the current would result, were fifty or one hundred of these interposed on a well insulated line. On one of the lines, sixteen are included in the circuit, each of which can unite to each or all the others—each receiver preserving a closed circuit while the transmitting operator manipulates with his key. Of course but one writes at a time. The business of the offices is conducted by operators, copyists, book-keepers, battery-keepers, messengers and inspectors or repairers. Messages to be transmitted are received, prepaid, the price estimated by a tariff whose elements are the distance transmitted and the number of words. The average rate being 25 cents for ten words 100 miles; these messages vary in value from 10 cents to $100. Messages thus received are filed according to destination, and sent in order of reception as nearly as the business of the line admits. As a general rule, the stations are written to in rotation, commencing with the most distant; the time used in performing the circuit varying, of course, with the amount of business and the condition of the wires.

The introduction of these stations to the circuit is sometimes perplexing. In Mr. Vail's work, "dependent" and "independ-

ent" circuits are described. The first consisting of a *single* wire and the ground. The wire broken by keys and the receiving operator, keeping the circuit closed, and breaking or closing at pleasure—such is the circuit always employed, for the various reasons already alluded to. The way in which this single wire is introduced at the stations may be understood from the diagram, (fig. 5,) and illustrated by the supposition of a break. When at

Fig. 5.



an intermediate office the line is found deranged from the evidence of a current unnaturally strong or weak, or from the entire want of a current, the inference is that the wire is broken on one or both sides of the office. Supposing the wire continuous from one terminus of the line to the other, and a battery at each, the current passes through the intermediate magnet without interruption, and the circuit established is termed a "through circuit." Now a derangement existing, the intermediate operator alters this "through circuit," and by connecting with the ground, makes two "short circuits." If the line is broken only on one side, a current is at once obtained from the battery of the unbroken side, and the arrangements for repair are guided accordingly. The diagram exhibits a means of instantly applying this test, as also a convenient method of dividing a long line into sections as the business may demand. The black dots A, B, C, D, represent brass terminations of conducting wires, sunk to a level with the surface of the operator's table; over their surface a metallic button plays, (Fig. 6.) This button connects each brass stud with its opposite, and a change in its position changes the direction and channel of the current at pleasure. Thus the intermediate operator wishes to break and close the "through circuit." He turns his button bringing B in connection with D. The course of the current can be easily traced. But again, cutting off his left-hand neighbor, he wishes to correspond with the right, the button, changed so as to connect A with C, the current passes directly to the ground through his instruments. Supposing a binding screw at S, the left or right-hand wire may thus be brought in connection with the ground. The buttons 1, 2 and 3, are simply used as convenient duplicate keys, or circuit closers, when the operator is receiv-

Fig. 6.

ing. In the economy of our lines the number of intermediate offices is of advantage, if their management is competent, as they facilitate the discovery and repair of difficulties and breaks, a consideration rendered important hitherto by the weakness of our structures. Each office has its peculiar call or signal, to which, when the line is in order, an immediate response is expected. Thus *n* expresses New York. The sound is so familiar as instantly to arrest the operator's attention, though he should be at a distance from the instrument. Thus the American telegraph is phonetic—it appeals to two senses. Long messages have been faithfully recorded from attentive listening to the peculiar sound of the instrument. There are systems of abbreviations too, many ordinary words and sentences being expressed by a single letter or numeral. By the aid of these and a quick ear, conversation may be carried on between operators with wonderful celerity. To the skillful operator, the little brass instrument becomes an articulate creature; it not only conveys his written thoughts, but expresses his passing emotions. He detects the *individual* with whom he converses and can recognize the effect of his own conversation as producing pleasure, vexation or indifference. In business correspondence too, abbreviations render the transmission so rapid that an ordinary penman fails to keep pace with it. On one occasion, with no allowance for repetition or delays, twenty-five thousand letters were transmitted in an hour and a half, by the aid of two instruments and wire.* That the actual business capabilities of the wires may be better understood, the brief statistics of a single day's business at one office may not be uninteresting. Two wires were at work, one through 200, the other through 500 miles. Four hundred and fifty private messages were sent or received, comprising every variety of business and information. The average length of these messages was twenty-five chargeable words, in addition to address, &c. Beside these, three entire hours were occupied in transmitting market and other intelligence, for publication, abbreviated as above. The line was pretty actively employed for sixteen hours, and being in good order, sixty or more messages were transmitted in rotation, without a word of repetition. A numerical statement of the operations of the telegraph can give however, but a faint idea either of their importance or value. It should be considered that the invention is used *only* in cases of urgency and importance—its *receipts* are not like those of other business, a trifling per-centage on previous outlay.

* This estimation may not be as readily appreciated as one made from newspaper columns; these however, vary very much in their amount of matter with the type and composition. Some containing eight times as much as others. The report alluded to embraced about three average columns, or ten pages of this Journal. A like amount of matter is now regularly telegraphed on the arrival of each ocean steamer from Europe.

Such being the capabilities of the telegraph, and such the simplicity of its details, its frequent derangement becomes an object of wonder, and it would seem that the invention might be made more reliable. The most thorough experience proves, that, setting aside *natural* difficulties, the requisites for reliability are few and simple. Firm structure, good instruments, efficient battery, competent human skill, but especially, thorough insulation. A want of any of these destroys reliability at once. The first. structure, have been generally incompetent, the poles so weak and small as to make it sometimes doubtful whether, in relation to the wire, it supported or was supported, the wire so badly secured as to break often without any violent external cause. If not broken, each of the ductile wires has been constantly liable to contact with its support or its fellow cord. Let us trace the effect of such contact. As the ground is used as a return conductor, as a wire of the tenuity of Wollaston's platina thread would be sufficient to conduct the current, and as the capacities of conductors vary with their size, defects in insultation become conductors to the earth. Suppose a line erected as our ordinary lines with a battery however at but one end. The current passing from the positive pole proceeds through the miles of conducting wire to the distant station, thence its *destination* is the negative pole, its conductor thereto the earth. As the wire acts as an obstruction in a certain proportion to its length, a connection with the earth at some point between the two stations would be preferred to that at the distant station. Thus a certain part of the battery current would be returned at the point of non-insulation, the force of the battery would be unequally distributed, the magnets on the battery end having a preponderance in proportion to the *extent* and *relative position* of the non-insulation. The best non-conductors we have are insufficient for perfect insulation. On a long line, a sufficient current is always returned through the posts to work the instruments, though the insulation be practically entire. The want of a few glasses makes a difference quite perceptible. The crossing of wires acts as described above, throwing upon the wire used, the aggregate non-insulation of the two. Did defective insulation act as a constant quantity, less difficulty would be experienced, but its effects are highly inconstant and variable. They are often such as might be attributed to the violent agitation, contact and separation of the wires, in a gale of wind.

Slight variation of current exists almost always—generally less at night than during the day, and being more prevalent on long than short circuits, they may be attributed to the electricity of the atmosphere; doubtless the wire in its passage through 500 miles of country is exposed to very different electrical states of the atmosphere.* For some time it was supposed impossible to work two

* See a valuable paper on this subject, by Prof. Jos. Henry, ii Ser., vol. iii, p. 25.

independent wires; experience has proved that the inability lay solely in the imperfection of structures. Two *copper* wires have worked independently and well through 300 miles. The wire is expected to work equally well through twice the distance. No mutual influence is exerted by the two currents. Some careful experiments, made with a view to ascertain whether a secondary current might not be induced in one wire from the primary current in the other, proved conclusively that no appreciable effects could be traced on either from any arrangement of the other with relation to battery or ground.

Rain, snow, &c. act as disturbing influences with less power than would be supposed, but in proportion to the excellence of insulation; since at times during severe storms, lines have worked well through their entire extent, and at others a light shower cuts off even the nearest station.

Aside from the enumerated difficulties, there is one which will probably always act temporarily and to some extent. During thunder-storms, elevated metallic conductors affording for the lightning a passage to the earth, the wires will often become so charged, that the fluid in its passage encountering the small wire of the receding magnet as an obstacle, will dart off to the nearest and largest conductor, or melt the small wire. Or if less of the fluid be present, its magnetic effects will be disclosed in the instruments, producing on them a spasmodic effect. To remedy or prevent such effects, two instruments, simple enough in idea and construction, have been devised. The one consists of a metallic globe surrounded with a ring of metal presenting to the globe a number of sharp points. The ring is adjustable so as to bring the points in the closest possible proximity to the globe and yet prevent contact. It scarcely need be added that the globe is thrown into the main circuit, (the current entering by a large, and passing out by a very fine wire,) the ring is connected with the ground. The other device consists of an arrangement, in construction, resembling the receiving magnet, (fig. 2.) The *main wire*, before coming to the instruments, connects with and includes the helices of this magnet, (whose wire is quite coarse,) and it connects also with the upright lever. The right-hand standard connects with the ground. The atmospherical current powerfully charges the magnet, the armature is attracted and the lever brings the points (*a a*) in contact—thus a ground connection is instantly formed and the current passes out. In this case, both dynamical and atmospherical currents are "turned out of doors." Though these devices may prevent the destruction of receiving magnets, neither can secure regularity to the working of the instruments, since currents will take each and every ground conductor, and enough passes through the receiving instrument to derange its adjustment.

To those interested in the subject of telegraphs, the conflicting claims of the Morse and House patents are at present discussed with some warmth. An accurate description of the latter is at present impossible, from the fact that the existing instruments are in pieces with a view to the construction of new ones for the use of western lines, and from the justifiable unwillingness of the proprietor at present to expose his devices. The relative complication of the instruments may be judged from the fact, that the House machine costs in construction more than ten times the amount of the other. The object of House's machinery is to make at one end of a wire, the revolution of a disc, upon whose edge the Roman letters are raised, synchronous with the operations of a lettered finger-board at the other end of the wire. So that at the touching of A on the finger-board, the wheel presents and impresses A on a slip of paper. The paper is moved so that the letters succeed each other as in ordinary printing, and a visible impression is made by an arrangement similar to the manifold writer.

The most conflicting opinions exist in regard to the practicability of the above arrangement, some asserting its accurate performance through several hundred miles, others again bringing forward good reasons for the improbability of the thing. Such discussions are however necessarily interested. The use of Morse's receiving magnet with the accompanying combination of circuit, is probably the chief security to that gentleman's patent; and the most important question at issue is, whether the House patent is available without this combination. If it prove to be, competition will doubtless place it throughout the country in opposition to Morse's. Meanwhile the advocates of Prof. Morse's claims, stoutly deny the possibility of its operation "per se," and anxiously await a fair, open and impartial trial of its practicability.

Lines Complete and in Operation, Nov. 1, 1847.

From	New York	to	Carmel,	N. Y.
"	"		Poughkeepsie,	"
"	"		Hudson,	"
"	"		Troy,	"
"	"		Albany,	"
"	"		Schenectady,	"
"	"		Little Falls,	"
"	"		Utica,	"
"	"		Rome,	"
"	"		Syracuse,	"
"	"		Auburn,	"
"	"		Geneva,	"
"	"		Canandaigua,	"
"	"		Rochester,	"
"	"		Buffalo,	"

509 miles.

From Troy to	Saratoga,	N. Y.	36 miles.
From Auburn to	Springport,	"	84 miles.
" "	Ithaca,	"	
" "	Elmira,	"	
From Ithaca to	Owego,	"	46 miles.
" "	Binghampton,	"	
From Syracuse to	Oswego,	"	38 miles.
From Buffalo to	Lockport,	"	25 miles.
" "	Niagara,	"	12 miles.
" "	Chippewa,	C. W.	
" "	Queenston,	"	150 miles.
" "	St. Catharine's,	"	
" "	Hamilton,	"	
" "	Toronto,	"	
From Hamilton to	Dundas,	"	75 miles.
" "	Woodstock,	"	
" "	London,	"	
From Toronto to	Oshawa,	"	376 miles.
" "	Port Hope,	"	
" "	Coburg,	"	
" "	Belleville,	"	
" "	Kingston.	"	
" "	Brockville,	"	
" "	Prescott,	"	
" "	Cornwall,	"	
" "	Montreal,	"	
From Montreal to	Berthier,	C. E.	180 miles.
" "	Three Rivers,	"	
" "	Quebec,	"	
From New York to	New Brunswick,	N. J.	224 miles.
" "	Princeton,	"	
" "	Trenton,	"	
" "	Philadelphia,	Pa.	
" "	Wilmington,	Del.	
" "	Havre de Grace,	Md.	
" "	Baltimore,	"	
" "	Washington,	D. C.	
From Washington to	Georgetown,	"	175 miles.
" "	Alexandria,	"	
" "	Fredericksburg,	Va.	
" "	Richmond,	"	
" "	Petersburg,	"	
From Philadelphia to	Lancaster,	Pa.	296 miles.
" "	Harrisburg,	"	
" "	Carlisle,	"	
" "	Chambersburg,	"	
" "	Bedford,	"	
" "	Pittsburg,	"	

From Philadelphia to		Port Richmond,	Pa.	106 miles.
"	"	Reading,	"	
"	"	Pottsville,	"	
From Lancaster to		Columbia,	"	25 miles.
"	"	York,	"	
From Pittsburg to		Wheeling	Va.	120 miles.
"	"	Wellsville,	"	
"	"	Zanesville,	O.	
"	"	Columbus,	"	
"	"	Dayton,	"	
"	"	Cincinnati,	"	
"	"	Massilon,	"	130 miles.
"	"	New Lisbon,	"	
"	"	Cleveland,	"	
From Cincinnati to		Lawrenceburg,	"	85 miles.
"	"	Madison,	"	
"	"	Louisville,	Ky.	
From New York to		Stamford,	Conn.	237 miles.
"	"	Bridgeport,	"	
"	"	New Haven,	"	
"	"	Hartford,	"	
"	"	Springfield,	Mass.	
"	"	Worcester,	"	
"	"	Boston,	"	
From Boston to		Portland,	Me.	74 miles.
"	"	Lowell,	Mass.	26 miles.

Total extent, 2989 miles.

Lines in Progress or Contemplated.

In progress.

From Petersburg to		Raleigh,	Va.	1427 miles.
"	"	Fayetteville,	N. C.	
"	"	Cheraw,	S. C.	
"	"	Camden,	"	
"	"	Columbus,	"	
"	"	Charleston,	"	
"	"	Augusta,	Ga.	
"	"	Savannah,	"	
"	"	Macon,	"	
"	"	Columbus,	"	
"	"	Franklyn,	Ala.	
"	"	Montgomery,	"	
"	"	Mobile,	"	
"	"	New Orleans,	La.	

From Buffalo to Detroit, ...	350	miles.
" Detroit to Milwaukie, . . .	350	"
" Bridgeport to Montreal, . . .	300	"
" Norwich to Worcester, . . .	85	"
" Louisville to St. Louis, . . .	300	"
	1385	"
	1427	"
	2812	"

Contemplated.

From Macon to Florida.		
" Macon to Tennessee, . . .	1000	miles.
" St. Louis to New Orleans, . .	1000	"
	2000	"

In computing the extent of lines in operation, the length of duplicate wires has not been taken into consideration; this will swell the amount to 3500 miles of telegraph at this moment in full operation,—(November, 1847.) The actual extent of *erected* wire is however much greater. The numerous branch lines that will shoot from the great southern route are not yet definitely arranged. The line projected from Buffalo to Milwaukie may be embarrassed in its progress, from conflicting claims in regard to priority of right to the territory, Mr. Henry O'Reilly insisting on its embracement in his great original contract. No doubt exists that the ground will be covered. The following general estimation is pretty nearly correct.

Lines complete, ...	2,989	miles.
Second wires complete, ...	511	"
Lines in progress, ...	2,812	"
" contemplated, ...	2,000	"
Second wires in progress, . . .	2,678	"
	11,000	"

ART. X.—*On the Fossil Remains of the soft parts of Foraminifera, discovered in the Chalk and Flint of the Southeast of England;* by GIDEON ALGERNON MANTELL, Esq., LL.D., F.R.S., &c.*

IN a microscopical examination of chalk and flint, undertaken for the purpose of testing the accuracy of the statement of M. Ehrenberg, that a considerable portion of the cretaceous strata is composed of minute organisms, I observed that the chambers of the shells of many *Rotaliæ* were filled with a substance, varying in appearance from a dark opaque brown, to a light transparent amber; and resembling in form, the soft bodies of existing species of Polythalamia.† I was particularly struck with the similitude between some of the fossils, and the recent *Nonionina* when deprived of its shell by immersion in diluted hydrochloric acid; and having, by the courtesy of Mr. Williamson of Manchester, procured Rotaliæ from mud dredged up in the Levant, I found among them several that contained the body of the animal partially collapsed, and of a dark brown color, which presented an analogous appearance. I was therefore led to infer, that the substance filling the cells of the flint Rotaliæ was the remains of the soft parts of the original animalcules, in the state of *molluskite*.‡

In a paper read before the Geological Society of London, and published in the Annals of Natural History for August, 1845,‖ I ventured to suggest this explanation of the origin of the fossils in question; but the conjecture was regarded by certain geologists as 'very startling and unsatisfactory;' and as the specimens were enveloped in flint, the appearance was attributed to an infiltration into the empty chambers, of mineral matter of a different color from the surrounding matrix; a circumstance of common occurrence, not only in Ammonites, Nautili, and other chambered Cephalopoda, but also in Polythalamia, which are frequently filled with chalk, flint, and silicate of iron.§ The

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* From the Trans. Roy. Soc., 1846. Part iv, p. 465. Only a small part of the cuts illustrating the memoir are here copied.

† The first flint specimen that came under my notice was discovered by my friend, the Rev. J. B. Reade, F.R.S.

‡ *Molluskite;* a name proposed by the author, (in a paper read before the Geological Society, but not published,) for the carbonaceous substance resulting from the soft bodies of testaceous mollusks that abounds in various limestones. See Medals of Creation, p. 431, and this Journal, i ser., xlv, 243.

‖ Notes of a Microscopical Examination of the Chalk and Flint of the Southeast of England, with remarks on the Animalculites of certain Tertiary and modern Deposits.

§ In these cases, the shells were probably either empty when enveloped in the liquid chalk or flint, or speedily became so by the the decomposition of the soft

Fig. 1.

usual appearance of the fossil Rotaliæ filled with chalk when viewed by transmitted light, and rendered semi-transparent by Canada balsam, is shown in the accompanying figure, (1.)

The unequivocal organic structure, however, discernible in the substance contained in the cells of the Rotaliæ by a high magnifying power, and of which no traces are observable in the mineral casts, and the identity of appearance in the fossils and the corrugated animal body in the Levant specimens, convinced me of the correctness of the explanation I had suggested. I therefore resolved to follow up the inquiry by an examination of Rotaliæ from chalk, in the expectation, that if the shell were dissolved by acid, indications of the body of the original animal might be detected in the residuum, in an unmineralized condition. After many fruitless experiments, I succeeded in procuring several examples of the soft bodies of Rotaliæ in an extraordinary state of preservation, from the grey chalk of Folkstone.

To Mr. Henry Deane of Clapham Common, an able chemist and microscopical observer, I am indebted for the most illustrative specimens; accurate figures of which, drawn by Mr. Mounsey, and M. Dinkel, are subjoined. These relics were obtained by subjecting a few grains of the cretaceous rock to the action of weak hydrochloric acid, by which means the calcareous earth, and the shells it enveloped, were removed; the residue consisted of particles of quartz, and of green silicate of iron, with which the chlorite chalk abounds, and numerous remains of the soft parts of animalcules. A small portion was then prepared in the usual manner with Canada balsam, and this was found to contain many Xanthidia, and the Rotaliæ hereafter described.

I have not had an opportunity of examining the structure of the living Rotaliæ; but from the recent observations of Ehrenberg, it appears that the organization of these minute animals is very simple, and has no relation whatever to that of the Cephalopoda, as was formerly conjectured. The body is enclosed within the shell, and occupies not only the outer chamber, but also all the cells *contemporaneously;* and the shell is pierced all over with minute pores like a sieve, through which tentaculæ protrude; there are also several soft transparent feelers or *pseudopodia*, which are instruments of locomotion. The shell of the Rotalia, therefore, though presenting the general form and cham-

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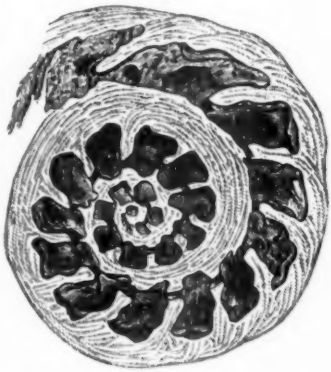
parts; but in the instances under examination, I conceive that the live animal was suddenly enclosed in its shell, and hermetically sealed, as it were, by the investing mineral matter, and thus the usual putrefactive process prevented.

bered structure of that of the Nautilus, is essentially different; for while in the shell of the latter, the animal occupies only the outer chamber, and all the internal compartments are successively-quitted empty dwellings, in the Polythalamia the body distinctly fills up *simultaneously* all the cells. When the shell is removed by weak hydrochloric acid, the soft body is exposed, and is seen to extend to the innermost chamber; and there is a connecting tube occupying the place of the siphuncle of the Nautilus, but which is the intestinal canal; for the cells of the shell contain the receptacles of the digestive sacs or stomachs, in which minute Infusoria (as Monads, Naviculæ, &c.), that have been swallowed by the animal, may sometimes be observed.

In the fossils, the appearance of the parts which I suppose to be the digestive organs, is that of a series of bladders or sacs, composed of a tough, flexible skin or integument, connected by a tube. These organs are more or less filled with a dark substance; those which are distended are always well-defined, while the empty ones are collapsed and disposed in folds, just as membranous pouches would appear under similar conditions. The sacs regularly diminish in size from the outer to the innermost cell, and vary in number from fourteen to twenty-six; being far more numerous than in the recent species. In some instances small papillæ are observable on the external surface of the integument; these are probably vestiges of the pseudopodia or tentaculæ.

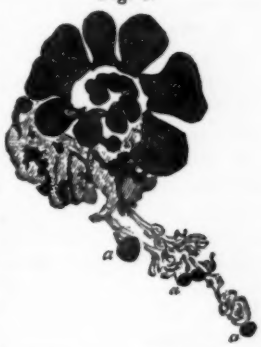
Fig. 2.



In fig. 2, the interior of the animalcule is completely exposed; the sacs and the intestinal canal are as perfect as in an individual recently dead, and just taken out of the sea. The folds of the sacs that are but partially filled with the brown endochrome, resemble the duplicatures produced by the shrinking, or corrugation, of a flexible integument. The outline of the shell is but dimly visible, and can only be rendered apparent by a peculiar arrangement of the mirror of the microscope; but it is sufficiently defined to show that the sacs occupy their respective chambers. As these two specimens are contained in semi-transparent flint, the appearances described may be supposed to have originated from the soft parts having undergone silicification, the brown endochrome of the original constituting the coloring material; but this hypothesis cannot be appli-

cable to many other examples, procured from the Folkstone grey chalk. These are associated with numerous particles of transparent white and green quartz; all vestiges of the shells having been destroyed by the acid. Fig. 3, is the body of a Rotalia deprived of its shell by the process previously described; it consists of fourteen sacs, in their natural position, which are filled with a dark substance, and present no folds or corrugations, as do the empty sacs in other examples. At the part corresponding with the outer compartment, a considerable space is occupied by a pale transparent material, extending in patches beyond and below, and enveloping several dark globular bodies (*a*), that resemble in shape the ova of certain Gasteropoda. That these belong to the same animal seems probable from the occurrence of similar ova in another fossil, which is the body of a Rotalia seen foreshortened in the horizontal plane; in this specimen four large sacs are exposed, and these exhibit in a striking manner the folded condition of the integument of which they are composed. The globular bodies (*ova?*) are twenty-one in number.

Fig. 3.



In another example the entire integument of the body of a Rotalia appears to be present, the shell having been wholly removed by the acid. The membrane of the largest sacs is very much corrugated, and disposed in numerous duplications, probably from the empty state of those organs; but the general contour of the original shell is preserved, and the inner subdivisions maintain an involuted discoidal arrangement. Some granules dispersed through a mass of light-brown matter, appear in the upper part of the specimen; and on several of the sacs there are papillæ, which may be regarded as indications of the bases of pseudopodia. On this fossil I cannot forbear to observe, that this extraordinary preservation of the soft delicate body of an animalcule invisible to the unassisted eye, through the innumerable ages that must have elapsed since the deposition of the chalk in which it was enshrined, is a fact not less remarkable than the occurrence of the carcass of the Lena mammoth, in the frozen soil of Siberia.

On examining by reflected light, under the microscope, some pieces of chalk collected from the stratum which yielded the fossils above described, minute particles of a brown color may be observed scattered over the surface; these I have no doubt are remains of the integuments of foraminifera; for in one instance,

three cells of the shell of a Rotalia lined with a similar substance, were exposed. Mutilated Rotaliæ, consisting of four or five sacs, and sometimes of but one, are common both in chalk and flint; and these invariably have a torn and collapsed appearance.

If the explanation I have suggested of the facts described be correct, and the fossils before us are the delicate soft parts of animalcules preserved in chalk and flint, in like manner as the bodies of mollusks occur as a carbonaceous substance in the Wealden freshwater limestones—this discovery, though relating to some of the minutest forms of existence, may yet prove an important element in many of the most interesting speculations of the geologists; for in strata in which no vestiges of shells, corals, or other dense organisms have been detected, the relics of countless myriads of beings may lie concealed.*

Chester Square, Pimlico, May, 1846.

Art. XI.—*On the Chemical Constitution of Gelatine and its Transformations;* by T. S. Hunt.

Notwithstanding the elaborate researches of Mulder, Liebig and others, the true chemical nature of the gelatigenous and proteinaceous compounds is as yet unsettled. The difficulties which attend a careful study of them, are greater than pertain to any other class of substances; from their high equivalents and the complexity of their molecules, they are peculiarly subject to change, and are often altered in the processes by which they are separated and purified. In addition to this, they are not capable, so far as is known, of forming any definite crystalline compounds, so that the chemist has no means of determining the purity of the substances upon which he operates. A correct understanding of the chemistry of physiology cannot, however, be attained without a thorough knowledge of these bodies; hence the attention of chemists has been particularly directed to them, and as a result we have the researches of Mulder upon proteine which have thrown great light upon the process of digestion, and the mode in which a large class of substances are assimilated. The nature of gelatine is as yet however involved in obscurity; its chemical

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* In confirmation of these views I may state, that Mr. Bailey, Professor of Chemistry in the United States Military Academy at West Point, whose high attainments as an accurate microscopical observer are well known, had arrived at the same conclusions, from the examination of American specimens, before he was apprised of the result of my researches. In a recent communication, he informs me that he has obtained, from the marls of New Jersey, not only casts of the interior of the shells of *Rotaliæ* and *Textilariæ*, but also the soft bodies of the animals, in the condition of molluskite. I have detected similar specimens in marl from the same locality, sent to me by Prof. Bailey.

relations, the part which it performs in nutrition, and the modes of its assimilation are unknown.

Before proceeding to the subject proposed, it will be well to recall some of the characteristics of the different nitrogenous organic compounds, which are divided into two widely dissimilar groups. The first of these comprises all of those substances generally known as the proteine compounds, gelatine, chondrine, the organic alkaloids, both natural and artificial, a number of azotized acids and some other principles, as amygdaline and asparagine. These are characterized by evolving ammonia when decomposed by heat, especially when in the presence of an alkaline base, and often by the action of acids and alkaline solutions. Many of them are artificially formed from substances which do not contain nitrogen, and the mutual relations are then such that the azotized bodies may be derived from them by the addition of the elements of ammonia and the abstraction of those of water, so that NH_2, NH, or sometimes N only, may be regarded as replacing one, two or three equivalents of oxygen; this reaction is often effected by the direct action of ammonia upon the organic substance. From these considerations we are led to regard the whole of this class as amidized species of non-azotized bodies. M. Gerhardt has conveniently distinguished them by the title of *ammonids*.

The second class are entirely artificial products, and are produced either by the direct union of nitric acid as the nitrates of the organic alkaloids, or by its combination with the separation of the elements of water. To these last belong nitro-benzene, pyroxyline and xyloidine, which are formed by the action of strong nitric acid upon organic substances. The late experiments of Cahours, Flores, Dumonte and other chemists, show that by employing a mixture of nitric and sulphuric acids, a great number of bodies, among which are sugar, glucose and mannite, are capable of yielding nitric species; these are distinguished from the first class by the appellation of *nitrids*. In these compounds NO_4 may be regarded as replacing an equivalent of hydrogen or more correctly perhaps the residue $NHO_6 - O_2 = NHO_4$ is substituted for H_2. From the large amount of oxygen which these bodies contain, they do not yield ammonia when decomposed; and they are very combustible and often explode when heated. The action of reducing agents upon them is peculiar; they combine with hydrogen and are converted into ammonids with the separation of the elements of water.

The analyses of gelatine prepared in different ways and from different substances, show a considerable variation in the proportions of its elements. The following are taken from Mulder's Physiology, p. 307, Am. Ed.

	Gelatine from hartshorn.		Isinglass.	Silk.
	I.	II.	III.	IV.
C	50·05	50·05	50·49	50·76
H	6·48	6·64	6·36	6·64
N	18·35	18·39	19·19	18·31
O	25·12	24·92	24·96	24·29

Scheerer who submitted to analysis the unaltered tissues, obtained somewhat different results.

	Air bladders.	Tendons.	Sclerotica.
	V.	VI.	VII.
C	50·56	50·96	51·00
H	6·90	7·19	7·08
N	18·79	18·32	18·72
O	23·75	23·53	23·20

In view of all these, Mulder proposes the formula $C_{13} H_{10} N_2 O_5$, which requires C = 50·37; H = 6·33; N, 17·95; O, 25·35. The per-centage of carbon accords very well with that of experiment: but although it may be said that the calculated numbers do not differ more from some of those obtained, than these do from each other, it is to be observed that the hydrogen and nitrogen are lower, while the oxygen is higher than any determinations have fixed them. Besides this, the formula is wanting in verisimilitude; the equivalents of carbon and oxygen are represented by odd numbers, and admitting that these express the relation of the equivalents, it will be necessary to double the present formula.

A consideration of the results of the decomposition of gelatine, will we think lead to a more probable formula. M. Gerhardt observed some years since, that when this substance is boiled for several hours with dilute sulphuric acid, a large quantity of sulphate of ammonia is formed, together with a sweet non-azotized substance which resembled grape-sugar and was susceptible of fermentation by yeast, affording alcohol and carbonic acid gas, thus placing its character beyond question. This reaction accorded perfectly with the characters of that class of azotized bodies to which gelatine has been referred, and seemed to indicate that it is to be regarded as an amidized species of glucose or some body differing from it only by the elements of water. On searching for a formula which should accord with the results of analysis, and at the same time harmonize with this view, it was found that it might be derived from an equivalent of cellulose or starch, and four of ammonia by the abstraction of twelve of water; $C_{24} H_{20} O_{20} + 4NH_3 = C_{24} H_{20} N_4 O_8 + 12HO$. The ordinary amides are formed by the substitution of the residue NH for O_2, but in hydro-benzamid and some other compounds, N is found replacing O_3 in perfect analogy to the formula proposed.

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* See Gerhardt's Précis de Chimie Organique, tom. ii, p. 521, *et seq.*

The number calculated from this present as close a correspondence with the results of analysis as those of Mulder; $C_{24}H_{20}N_4O_8$ require C, 50·704; H, 7·04; N, 19·71; O, 22·53. The oxygen agrees very well with that obtained by Scheerer in his analyses, which differ in this respect by about two per cent. from the number required by Mulder, the carbon corresponds closely, as well as the hydrogen which is decidedly too low in the old formula, while the nitrogen is considerably above that obtained by experiment; but the formula is altogether a closer approximation than that of Mulder, and when we consider the results of the decomposition of gelatine which cannot be accounted for by that, it can scarcely be doubted that it is the true one.

The transformation with dilute sulphuric acid will then consist in the assimilation of the elements of water to generate ammonia and dextrine or a similar substance which by the farther action of the acid is converted into glucose.* The insoluble form in which gelatine exists in the tissues is related to the soluble modification produced by the action of boiling water, as cellulose and starch are to dextrine, or rather perhaps as the gelatigenous tissues of plants are to pectine.† And although too much importance should not be attached to mere analogies, it is interesting to consider that the substance which in the tendons and cartilaginous tissue of the bones, constitutes the frame-work of the animal organism, should be but an azotized species of that which in the form of ligneous fibre sustains the same important part in the vegetable structure.

That gelatine, although not capable of replacing the proteine compounds, is one of the substances fitted for the support of animal life is generally admitted; but although Liebig with his accustomed sagacity, placed it among the elements of respiration, a definite knowledge of the manner of its assimilation is still wanting. The proteine bodies are found in the circulation but slightly modified, and sugar is detected in the blood when it or any amylaceous substance has been taken as food; but I am not aware that gelatine has ever been observed either in the chyle or blood. What becomes of it when taken into the stomach? This question may be readily solved upon the view which I have

* The action of nitric acid upon glue requires examination; Berzelius (Traité, tom. vii, p 707, Ed. Franc. 1833,) states that it yields oxalic and malic acids. As the saccharic is a product of the action of dilute nitric acid upon sugar and was by the earlier chemists mistaken for the malic, it is probable that that obtained from gelatine will prove to be the saccharic. Berzelius also asserts that malic acid is a product of the action of nitric acid upon fibrine.

† The late researches of MM. Poumarede and Figuier and M. Soubeiran have shown that pectine is isomeric with lignine, and that it exists in the plant as an organized tissue which is partially changed into the soluble form by the action of boiling water, and more completely by the action of dilute acids. This tissue constitutes almost the whole of the endo-carp of the grape and gooseberry. Journal de Pharm. et de Chimie, June, 1847, p. 417, and Aug. 4, p. 81.

given of its composition. In the process of digestion it probably takes up the elements of water and is transformed into ammonia and glucose; the latter absorbed by the coats of the stomach finds its way directly into the circulation, or perhaps converted into fat becomes an element of the chyle, while the ammonia in a saline combination is excreted by the ordinary channels.

Baron Liebig in his late admirable researches in animal chemistry,* has shown that the flesh-fluid of both herbivorous and carnivorous animals contains free lactic acid, and M. Bensch has found that the milk of dogs fed entirely upon flesh affords milk sugar. From the results of the decomposition of gelatine, there can be no doubt as to the source of both these substances, whose origin it would otherwise be difficult to explain.

It is believed that a somewhat similar view to that we have taken of gelatine, may be extended to the proteine compounds, and one which will tend to settle the vexed question of its nature; some remarks upon this may form the subject of another communication.

Montreal, Nov. 1st, 1847.

Art. XII.—*Of the Law which governs the flow of Elastic Fluids through Orifices;* by Eli W. Blake.

The subject announced at the head of this article, is not only interesting considered simply as a subject of scientific inquiry, but it is also a matter of practical importance in its relations to several branches of mechanism. Among these may be instanced, as perhaps first in importance, the bearing of the subject upon the construction of the steam-engine. The size of the pipes and valves which conduct the steam to and from the working cylinder, should be properly adjusted to the size and velocity of the piston. In general, the larger these pipes and valves the better, so far as respects the power of the engine. But there are inconveniences attendant on making them large; and in order to make a due compromise between the inconvenience that may be incurred on the one hand, and the amount of power that may be sacrificed on the other, it becomes necessary to understand correctly the law which governs the flow of elastic fluids through orifices. Treatises on the dynamics of fluids have not omitted to give rules for the determination of such questions; but it will be seen in the course of this article that those rules are very defective.

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* See Am. Jour. of Science, ii ser., iv, p. 135.

If the velocity with which a fluid flows through an orifice from one vessel into another be represented by V, the density under which it passes the orifice by D, and the area of the orifice by S, then the product VDS is the measure of the quantity of fluid discharged in a given time. It is an established law in the dynamics of fluids, that the velocity of the flow is directly as the square root of the pressure and inversely as the square root of the density. If then the efficient pressure which produces this flow be represented by P, the general law expressed by symbols will be,

$$VDS \propto \frac{DS\sqrt{P}}{\sqrt{D}}.$$

The above expression is in accordance with the received theory, and properly understood it is correct, and applicable to all fluids, elastic as well as inelastic. But it must be observed that D in this expression must in all cases represent the *density under which the fluid passes the orifice.*

In all the treatises on the dynamics of fluids that I have examined, the quantity D in the foregoing expression represents the *density of the fluid in the discharging vessel:* it being assumed that the fluid passes the orifice without change of density. This assumption is correct so far as respects inelastic fluids, but as respects elastic fluids it is far otherwise. A particle cannot even *begin* to approach the orifice without a change of density. Surrounded by other particles, it will not begin to move until the pressure before it becomes less than the pressure behind it. If the pressure before it is less than the pressure behind it, then the density there is less also, and consequently the density of the particle itself is diminished, for that must be intermediate between the density before and behind it; and as it cannot begin to move without a change of density, so for the same reasons its motion cannot be accelerated without a further change of density. Thus for every increment of its velocity in its approach to the orifice, there must be a corresponding decrement of its density. Hence it is evident that the fluid passes the orifice under a density less than the density in the discharging vessel.

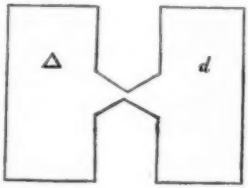
Again, there is an error in the received theory, in considering the efficient pressure which causes the discharge, (represented by P in the above expression,) as equal in all cases to the difference of pressure in the two vessels. The true amount which is to be deducted from the pressure in the discharging vessel, in order to find the efficient pressure that produces the discharge, is the elastic force that is due to the density which the fluid has in its passage through the orifice; for it is obvious that that alone reacts against the pressure in the discharging vessel. From this consideration also we may arrive at the same conclusion as was deduced in the last paragraph, viz. that the fluid must pass the

orifice with a diminished density; for otherwise the elastic force of the fluid in the orifice would be a perfect counterpoise to the pressure, and there could be no flow.

From what precedes it will be apparent that in the application of the general expression,

$$VDS \propto \frac{DS\sqrt{P}}{\sqrt{D}}$$

to the case of elastic fluids, the density of the fluid in the orifice, represented by D, is an unknown quantity, having a value somewhere intermediate between cypher and the density of the fluid in the discharging vessel; also that the efficient pressure which produces the discharge, represented by P, is an unknown quantity whose value is dependent on that of D. We will now proceed to elicit a general rule for the determination of the values of D and P in every case that can occur.



In the annexed figure let △ be the discharging vessel containing fluid whose density is △, and let *d* be the receiving vessel, which for the present we will consider a vacuum. Let the smallest place in the passage leading from one to the other be the orifice, and let its area be S, and let D represent the unknown density with which the fluid passes the orifice. Since the pressure is as the density, the density may be employed to express the pressure. Then it follows from the preceding observations that the efficient pressure which produces the discharge is △ − D. Since the velocity will be directly as the square root of the pressure and inversely as the square root of the density, we have,

$$V \propto \frac{\sqrt{(\triangle - D)}}{\sqrt{D}}.$$

Multiplying this expression by D and reducing, we have $VD \propto \sqrt{(\triangle D - D^2)}$.

Now if we conceive several sections to be made across the passage at different points on each side of the orifice, and if the areas of these sections are respectively S′, S″, &c. the velocities of the fluid in them V′, V″, &c. and the densities D′, D″, &c. V′D′S′, V″D″S″, &c. are the measures of the quantities of fluid that pass through these sections respectively in a given time. But when the current is established, the same quantity flows through each in a given time. Therefore $V'D'S' = V''D''S'' = VDS$. Now VDS being a constant quantity, if each of the factors vary, VD will be a maximum when S is a minimum. But S is a minimum at the orifice; and therefore VD is a maximum at the orifice. But we have before found $VD \propto \sqrt{(\triangle D - D^2)}$; and there-

fore when VD is a maximum $\sqrt{(\triangle D - D^2)}$ must likewise be a maximum. Now when $\sqrt{(\triangle D - D^2)}$ is a maximum $D = \frac{\triangle}{2}$. Hence when the discharge is into a vacuum, the density of the fluid at the orifice is equal to half the density in the discharging vessel.

For convenience in the illustration, we have made the passage from one vessel to the other in the figure, divergent each way from the orifice; but our reasoning would obviously be equally applicable if the orifice opened directly from one vessel into the other, without the intervention of the divergent tubes.

Let us now inquire what will be the value of D when the receiving vessel contains fluid of any density less than that in the discharging vessel.

Let the density in the receiving vessel be d. Then d is a limit beyond which the fluid cannot expand, either before or after it passes the orifice; so that D can never be less than d. As in the preceding case $\sqrt{(\triangle D - D^2)}$ was the maximum for all the values of D that can be assigned from cypher to $\triangle$, so in this case, and for the same reasons, $\sqrt{(\triangle D - D^2)}$ must be the maximum for all the values of D that can be assigned between d and $\triangle$. But we found in the other case that the maximum occurs when $D = \frac{\triangle}{2}$. If then this value of D is assignable between d and $\triangle$, the maximum must in this case also occur when $D = \frac{\triangle}{2}$. But this value of D will always be assignable between d and $\triangle$, if d be not greater than $\frac{\triangle}{2}$. Therefore if d be any quantity not greater than $\frac{\triangle}{2}$, D will be equal to $\frac{\triangle}{2}$. In other words, if the density in the receiving vessel be not greater than half the density in the discharging vessel, the density in the orifice will be equal to half the density in the discharging vessel.

Again, from the nature of maxima and minima, it is obvious that $\sqrt{(\triangle D - D^2)}$ will be a maximum when, of all the values that are assignable to D, that value is assigned which differs least from $\frac{\triangle}{2}$. Hence, if d exceed $\frac{\triangle}{2}$, so that D must have a value greater than $\frac{\triangle}{2}$, then $\sqrt{(\triangle D - D^2)}$ will be a maximum when D has the smallest value that is assignable to it. Now the smallest value that is assignable to it in this case is $D = d$. Hence, if the density in the receiving vessel exceed half the density in the discharging vessel, the density under which the fluid passes the orifice is equal to the density in the receiving vessel.

Thus we have found for the value of D, $D=\frac{\Delta}{2}$ if d is not greater than $\frac{\Delta}{2}$; if otherwise, $D=d$. And for the value of P (since $P=\Delta-D$) we have $P=\frac{\Delta}{2}$ if d is not greater than $\frac{\Delta}{2}$; if otherwise, $P=\Delta-d$.

In applying the general dynamic law $VDS \propto \frac{DS\sqrt{P}}{\sqrt{D}}$ to the case of elastic fluids, the values of D and P should therefore be assigned in accordance with this rule.

We have already remarked that treatises on the dynamics of fluids, in applying the above general expression to elastic fluids, put D as equal to Δ, and P as equal to $\Delta-d$ in all cases. This, as will appear from the above rule, makes D too large in all cases; and P also too large whenever d is less than half Δ. In the case of a discharge into a vacuum, it makes each of these quantities double what it should be. In constructing a formula to express the *velocity* of the flow into a vacuum, these errors balance each other; so that in that particular case the result is the same as if the values of these quantities were assigned in accordance with our rule; for by our rule $V \propto \frac{\sqrt{\frac{\Delta}{2}}}{\sqrt{\frac{\Delta}{2}}}=1$, and by the old rule $V \propto \frac{\sqrt{\Delta}}{\sqrt{\Delta}}=1$.

Again, since $\frac{\sqrt{\frac{\Delta}{2}}}{\sqrt{\frac{\Delta}{2}}}$ is a constant quantity however Δ may vary, it follows from our rule that the *velocity* of the flow into a vacuum is a constant quantity, being the same for every density in the discharging vessel. The same also results from the old theory.

But in constructing a formula to express the *quantity that will flow into a vacuum in a given time*, the results of the two rules will differ widely. For, since the old rule gives the velocity of the flow correctly, and at the same time puts its density at double what it should be, it follows that the old rule makes the quantity discharged in a given time double what it should be.

Hence it appears that in a steam engine, the valves and pipes which convey the steam from the working cylinder to the condenser, must be of double the size that would be assigned to them by the old rule in order to discharge the contents of the working cylinder in a given time, without increased reaction upon the piston.

It appears from the rule as stated above, for finding the values of D and P, that the quantity *d*, which expresses the density of the fluid in the receiving vessel, will not enter at all into the formula which expresses the velocity of the flow, nor into that which expresses the quantity discharged in a given time, provided it be equal to or less than half the density in the discharging vessel. Hence it follows that the fluid in the receiving vessel, if its density does not exceed half the density in the discharging vessel, will have no effect whatever upon the flow. Consequently air or steam will rush into a vacuum no faster than into a vessel containing fluid of half its density. On the contrary both the velocity of the flow and the quantity discharged in a given time will be the same in both cases; and so also if the density in the receiving vessel is any quantity *less* than half the density in the discharging vessel, the flow will be the same in velocity, quantity, and density, as into a vacuum. Accordingly a vessel containing steam of a density due to a pressure of ten or any other number of atmospheres, will empty itself no faster into a vacuum than into the open air, until in the progress of the discharge, the density is reduced below that due to the pressure of two atmospheres. It will be readily seen that these concluclusions have an important bearing upon the construction of the steam engine.

ART. XIII.—*On the Comet of 10th month,* (*October* 1st,) 1847; by WILLIAM MITCHELL, of Nantucket.

THIS interesting body, as it has been denominated by Prof. Peirce, was first discovered by Maria Mitchell of Nantucket. As a relaxation from the severer toil of a systematic course of periodical observations, she had employed the intervals through the last year in sweeping for comets; but her labors had hitherto been only rewarded by a familiarity with comet-resembling nebulæ, which she had constantly and carefully recorded. The instrument employed on these occasions was a forty-six inch refractor with three inches of aperture, mounted on a tripod, and furnished with a terrestrial eye-piece of moderate power.

At 10*h*. 50*m*. of the evening above named, a circular nebulous body appeared in the field of the comet-hunter, a few degrees above Polaris (then nearly on the meridian) and nearly corresponding with it in right ascension. There was scarcely a doubt of the cometary character of this object, inasmuch as the region which it occupied, had often fallen under the scrutiny of the observer. Still, as the object was faint and the weather uncommonly clear, a possibility existed that this too was a nebula not before observed.

On the evening of the 2d, its change of place was manifest, and at 11*h*. 46*m*. 55*s*., its meridian passage was taken by a transit instrument, the right ascension being 0*h*. 11*m*. 08·96*s*., and declination +84° 22′, as indicated by the instrument. No appearance of condensation of light towards its center, nor any indication of a train could be detected. It is evident that its apparition even to the telescope was sudden. Its first apparent motion was inconsiderable, and the region of its discovery had been constantly swept over by the assistant observer at Cambridge, with his excellent comet-seeker, and as late as the previous evening. This idea is also strengthened by the subsequent rapid increase of the brilliancy of the comet, and the acceleration of its apparent motion. In clearer skies and by better instruments an earlier observation might have been made.

On the 3d, its motion and brightness had much increased, and at 9*h*. 27*m*. its right ascension was found to be 22*h*. 10*m*. 49*s*., and its declination +84° 52′. A slight increase of light towards its centre was noticed by one observer. The observations of this evening were much interrupted by passing clouds, and during a period of obscurity, the comet must have passed very near the star 7851 of the Catalogue of the British Association. The observations of the evening were very imperfect. On the 4th, all observations were forbidden by the weather. On the 5th, the evening was delightful. At an early period, it was evident that the comet would transit a fixed star of the fifth magnitude, number 6206 according to the catalogue above named, or 40, according to Flamsteed, and this means was relied upon for the determination of its position, and it did not disappoint the observer. Preparations were made to note the beginning and end of the transit; but the border of the comet proved too uncertain to rely upon. At 10*h*. 54*m*., however, the star appeared to be exactly in the centre of the comet; during several seconds, it was impossible to determine, with a power of 100, in which direction, was the greatest extent of nebulosity. It appeared in fact like the nucleus of the comet shining through it with undiminished brilliancy. The position of this star as given in the catalogue for the first day of first month, January, 1850, is, R. A. 18*h*. 11*m*. 15·40*s*., and Declination +79° 58′ 26″·6, which, being reduced, gives for the star and hence for the centre of the comet at the period of observation, R. A. 18*h*. 11*m*. 13·40*s*., and Declination +79° 57′ 57″·6, and this may be deemed the best position obtained at Nantucket.

On the 6th, the comet was manifest to the naked eye, and continued to increase in brightness till the light of the moon obscured it, moving rapidly toward the Equinoctial and slightly diminishing its Right Ascension.

On the 9th, as seen at Cambridge, it exhibited a faint train, a degree and a half in length and opposite to the sun. The fol-

lowing positions of the comet were taken at the Cambridge Observatory, most of them by the great refractor, and kindly furnished by George P. Bond, the assistant observer; and from these the elements of each computer have been calculated.

Date.												
1847. Oct.	7th,	7h.	56m.	31s.	Comet's	A. R.	17h.	10m.	56s·2	Dec.	+70°	01′ 18″
"	" 9th,	6	48	11	"	"	16	44	14·4	"	+55	31 51
"	" 11th,	8	09	00	"	"	16	32	00·2	"	+36	38 07
"	" 14th,	7	42	54	"	"	16	20	34·7	"	+ 9	51 17
"	" 15th,	7	27	27	"	"	16	17	59	"	+ 2	36 13
"	" 18th,	6	34	44	"	"	16	11	01	"	−13	18 49

Prof. Peirce's Elements, from the places of October 7th, 11th, 14th, and 18th.

Perihelion passage, . . .	Nov. 14·41328
Perihelion distance, ...	0·32945
Long. of Perihelion, . .	274° 16′ 49″
" " Asc. Node, ...	190 51 03
Inclination, ...	71 55 27
Motion, Retrograde.	

George P. Bond's Elements, from the places of the 7th, 9th, and 11th.

Perihelion passage, . . .	Nov. 14·6935
Perihelion distance, ...	0·3468
Long. of Perihelion, . . .	276° 24′
" " Asc. Node, ...	191 01
Inclination, ...	72 27
Motion, Retrograde.	

Maria Mitchell's Elements, from the places of the 9th, 11th, and 14th.

Perihelion passage, . . .	Nov. 14·499
Perihelion distance, ...	0·341348
Long. of Perihelion, . . .	274° 10′ 06″
" " Asc. Node, ...	189 35 29
Inclination, ...	71 33 32
Motion, Retrograde.	

NOTE.—We have received in "the Washington Union" of Nov. 30, a notice of this comet by Lieut. Maury, giving the following ephemeris from Rumker's parabolic elements, by Prof. Keith, U. S. N.

Date.	Washington, m. t.	A. R.	Declination.	Log. Dist	Brilliancy.
Nov. 24,	6h. 12m. 43s.	15h. 00m. 38s·45	−24° 38′ 12″·6	0·1219	2·9
" 28,	" 13 03	15 01 23 ·73	−20 41 43 ·5	0·1349	2·0
Dec. 2,	" 13 16	15 03 41 ·91	−16 57 17 ·9	0·1432	1·4
" 6,	" 13 25	15 06 50 ·03	−13 23 58 ·3	0·1488	1 0
" 10,	" 13 30	15 10 27 ·88	− 9 59 12 ·4	0·1523	0·8
" 14,	" 13 33	15 14 22 ·10	− 6 39 28 ·2	0·1542	0·7
" 18,	" 13 35	15 18 24 ·26	− 3 32 56 ·2	0·1551	0·6
" 22,	" 13 35	15 22 28 ·61	− 0 07 25 ·6	0·1552	0·5
" 26,	" 13 34	15 26 30 ·79	+ 3 08 41 ·1	0·1547	0·4
" 30,	" 13 33	15 30 27 ·24	+ 6 26 40 ·3	0·1540	0·3

The places are corrected for aberration. The brilliancy of the comet is taken as unity, when the earth and comet are at equal distances from the sun and each other.

ART. XIV.—*Results of Astronomical Observations made during the years* 1834, 5, 6, 7, 8, *at the Cape of Good Hope; being the completion of a telescopic survey of the whole surface of the Heavens, commenced in* 1825; by Sir JOHN F. W. HERSCHEL, Bart., K.H., &c. &c. &c. London, 1847. pp. 472. 4to.*

ASTRONOMERS in the old world and new, have for several years been eagerly looking for the appearance of this great work, which should disclose to them the hidden treasures of the Southern Hemisphere. Their impatient curiosity, we are confident, will suffer no disappointment. It is a splendid work, even in its exterior, affording no indifferent specimen of the state of the arts in Great Britain; but those for whom the work is more especially designed, will not be long detained in surveying the excellence of the structure without, but will hasten to feast their eyes on the cabinet within.

From the year 1825 to 1833, Sir John Herschel prosecuted the researches on the Nebulæ commenced by his illustrious Father; a field of labor which has not inappropriately been called the "romance of astronomy." A mind which has long been conversant with this fairy region of the Universe, can hardly find sufficient aliment among these nether worlds; but, when all the objects of this class within its native skies are brought under its dominion, Alexander-like it sighs for new worlds to conquer.

Accordingly, in the year 1833, after Sir John Herschel had finished his review of the Nebulæ visible in the latitude of Slough, he took his departure for the Cape of Good Hope, for the purpose of completing his survey of the heavens by adding to the list, already swelled by the united labors of father and son to the number of 2307, the nebulæ of the southern hemisphere. He took with him the twenty-feet reflector which he had already employed with such distinguished success in his northern survey, and a seven-feet equatorial, besides such smaller instruments as his exigencies might probably require. He set sail on the 13th of November, 1833; a day memorable in the annals of this country for the occurrence of the great *Meteoric Shower*, which first drew the attention of the scientific world to a new department of observation and speculation. Although several gales set in on the coast of Northern Europe, immediately after he sailed, yet he was so fortunate as to escape them, and arrived safely at Table Bay on the 15th of January, 1834.

The place of observation selected, was a spot near the mansion of a Dutch proprietor,—a retreat which bore the name of *Feldhausen*, about six miles from the Cape, "a spot charmingly situated on the last gentle slope at the base of Table Mountain."

* We are indebted for this Review, to Professor OLMSTED, of Yale College.

There had been, for some time, a Royal Observatory at the Cape, belonging to the British government, under the direction of Thomas Maclear, Esq., an able and accomplished astronomer, from whom Sir John received every courtesy and assistance it was in the power of that gentleman to afford him. But, in his ordinary labors, Sir John had only the aid of an assistant whom he had trained in England, not only in "working and sweeping," but also in executing various mechanical operations essential to labors of this description. "This indispensable manual aid excepted, (says our author,) it is right to mention that the whole of the observations, as well as the entire work of reducing, arranging, and preparing them for the press, has been executed by myself. The repolishing of the reflectors it will of course be understood, could be delegated to no other person."

When we first opened this ponderous volume, and glanced over its pages, we could have scarcely believed on any other authority than that of the author himself, that such a vast number of the most refined and difficult observations as it records, and such immense labor as their reduction must have involved, could have been the work of a single individual. To say nothing of the consummate skill evinced on every page, the patient toil and untiring perseverance implied in this work would have done honor to Kepler himself.

Sweeping in arcs of 3° of North Polar distances, was prosecuted in the absence of the moon on all occasions when the weather permitted, and the definition of the stars was such as to render it worth while to do so. The *climate* of the Cape, in reference to astronomical observations, Sir John Herschel represents as on the whole very favorable, especially when compared with the foggy atmosphere of England. This is particularly the case in the cooler months from May to October, when the state of the air, in respect to definition, is habitually good, and imperfect vision is rather the exception than the rule. The best nights occur after the heavy rains, which fall at this season, have ceased for a day or two. On these occasions, the tranquillity of the images, and the sharpness of vision, is such, that hardly any limit is set to magnifying power, but what arises from the aberrations of the specula.

The author concludes his "Introduction" with a just tribute to the late Duke of Northumberland, and informs us that, to the munificent donation by his Grace of a large sum in aid of the publication of this work, it owes its appearance as a single and separate work, instead of a series of unconnected memoirs, scattered over the volumes of academical bodies. The lamented decease of that illustrious nobleman, prevented his witnessing its final completion; but his liberal intentions have been fully carried out "by his successor to his titles and his spirit." The whole commonwealth of astronomers, we are confident, will share with

Sir John this sentiment of gratitude to these distinguished patrons of science.

The leading subjects which successively occupy the pages of this great work are, first, Nebulæ of the southern hemisphere; secondly, Double Stars of the same region of the heavens; thirdly, Astrometry, or the numerical expression of the apparent magnitudes of the stars; fourthly, the Distribution of the Stars, and the Constitution of the Galaxy in the southern hemisphere; fifthly, Observations on Halley's Comet, with remarks on its Physical Constitution, and that of Comets in general; sixthly, Observations on the Satellites of Saturn; seventhly, Observations on the Solar Spots.

The number of nebulæ and clusters comprised in this catalogue, amounts to 1708, of which 89 had been previously observed at Slough, and are included in the northern catalogue.* As a general fact, the southern hemisphere is not so rich in nebulæ as the northern, although it contains individual specimens of surpassing richness. After reducing those of both hemispheres to a chart ingeniously contrived, so as to exhibit them most favorably in their mutual relations and positions, the author comes to the following conclusions:

1. That the distribution of the Nebulæ is not like that of the Milky Way, in a zone or band encircling the heavens; or, if such a zone can be at all traced out, it is with so many interruptions, and is so faintly marked out through by far the greater part of its circumference, that its existence can be hardly more than suspected.

2. That one-third of the whole nebulous contents of the heavens, are congregated in a broad irregular patch, occupying about one-eighth of the whole surface of the sphere; chiefly, indeed almost entirely, situated in the northern hemisphere, and occupying the constellations Leo, Leo Minor, the body, tail, and hind legs of Ursa Major, the nose of Camelopard, and the point of the tail of Draco, Canes Venatici, Coma Berenices, the preceding leg of Bootes, and the head, wings, and shoulder of Virgo. This, for distinction, he calls the *nebulous region of Virgo.*

3. That within this area, there are several local centres of accumulation, where the nebulæ are exceedingly crowded, viz. from 59° to 62° of North Polar Distance, in the 13th hour of Right Ascension, between the northern part of Coma, and the fore legs of Chara, as also, in the same hour, from 72° to 78° N. P. D.,

* Clusters as distinguished from Nebulæ, are patches of light visible to the naked eye, usually exhibiting a confused luminosity, but which a good eye, without a magnifier, will perceive to consist of stars. The most conspicuous clusters are the Pleiades, Berenice's Hair, and the luminous spots in the head of Orion, the sword handle of Perseus, and the bee hive in Cancer. Sometimes, however, the term cluster is extended to embrace all nebulæ which are, by the telescope, resolvable into stars.

between the palm branch and northern wing of Virgo; and again in the same hour, from 80° to 87° N. P. D., in the northern wing and breast of Virgo. Northward, the nebulous area terminates almost abruptly with a very rich patch, between the nose of Camelopard and the tail of Draco. The line of greatest condensation connecting these most condensed patches, is irregular and wavy, without appearance of reference to any one particular centre; and the shading off, though patchy, is on the whole gradual.

4. That the *southern* portion of this great nebulous region, extends but little, at least with any marked intensity, beyond the equator, though it may perhaps be considered as prolonged by one or two pretty rich patches in the 13th and 14th hours of R. A. as far as the 141st degree of N. P. D., where it is abruptly terminated. These patches occupy the point of the southern wing of Virgo, and the region about the tail of Hydra, and head of Centaurus. The lesser nebulous region in the northern hemisphere, extending in R. A. from about 22*h*. to 2*h*., and from 50° to 60° N. P. D. to the equator, beyond which it also projects considerably into the southern hemisphere, is much less concentrated, and has none of those densely congregating groups, or centres of accumulation, which form so distinct a feature in the other. Confining ourselves at present to its development in the northern hemisphere, it occupies the chest and wing of Pegasus, and the southern Fish, the area included by the connecting band of the Fishes, the northern Fish, and nearly the whole of Andromeda. This the author calls the *nebulous region of Pisces.*

5. That between these principal masses, an almost total disconnection exists throughout the region from 16*h*. to 19*h*. on the one hand, and from 3*h*. to 6*h*. on the other hand, from the pole down to the equator; for the few nebulæ sporadically scattered over this great area, are quite insufficient to convey any idea of junction, though perhaps a thread of connection may be traced across the head and sword of Perseus through Camelopardalus, with the dense mass of nebulæ which forms the northern limit of the nebulous region of Virgo. This barren region includes the constellations Aries, Taurus, the head and upper part of the body of Orion, Auriga, Perseus, Camelopardalus, Draco, Hercules, the northern parts of Serpentarius, the tail of Serpens, that of Aquila, and the whole of Lyra. Sporadic nebulæ, increasing in frequency with the increase of right ascension from the 6th hour, over Canis Minor, Gemini, Lynx, and Cancer, lead gradually, but without any other prevalent feature in their distribution, to the region of Virgo, and complete our survey of the northern hemisphere.

6. That in the southern hemisphere, a much greater uniformity of distribution prevails. If we except the two Nubeculæ, [Magellanic clouds,] which are full of nebulæ, and the greater of

which is even richer in objects of that class than the densest portion of the northern group, the general character of this hemisphere, is that of alternating patches of nebulæ, and vacuities of greater or less extent, some of the latter, however, being very extensive. In one of those vacuities, in which comparatively few nebulæ occur, the south pole is situated, having one nebula, however, in half a degree of it, as the north pole has also one within five or six minutes. This barren region extends nearly 15° on all sides of the pole, and immediately on its borders occurs the smaller Nubecula.

One of the most remarkable features in the southern nebulous system, is the extraordinary display of fine resolved and resolvable *globular clusters*, which occurs between 16*h*. 45*m*. and 19*h*. in R. A., in the region occupied by Corona Australis, the body and head of Sagittarius, the tail of Scorpio, with part of Telescopium and Ara. Here in a circular space of 18° radius, we find collected no less than thirty of these beautiful and exquisite objects.

The general conclusion which our author draws from this survey is, that the nebulous system is distinct from the sidereal, though involving and to a certain degree intermixed with the latter. Our system he regards as belonging to the nebulous region of Virgo, being situated somewhat beyond the borders of its denser portion. "It must not be left out of consideration, (says he,) and has been distinctly remarked by Sir William Herschel as an element of whatever speculation a closer attention to this subject, and a more perfect classification of nebulous objects, may lead us to indulge in, that the most condensed portion, and what may fairly be regarded as the principal nucleus of the region of Virgo, *is situated almost precisely in one pole of the Milky Way.* Taking that great circle as a horizon, the whole of that stratum forms, as it were, a canopy occupying the zenith, and descending thence to a considerable distance on all sides, but chiefly on that towards which the North Pole lies. The phenomena on the other side of the Milky Way, though much less characterized, are not altogether dissimilar, the nebulous region of Pisces and Cetus standing, on the whole, in pretty nearly the same relation to that circle, the most condensed part of that stratum being elevated at an altitude of between 60° and 70° above its plane."

Among the treasures contained in the great work under review, not the least valuable are the numerous *delineations* of rare celestial objects given in the plates at the end of the volume. Of these there are seventeen, comprising about eighty drawings of the most elegant description. In estimating the various gifts that must be combined to form the great astronomer, a sufficient degree of importance has not been ascribed to the power of delineating, with delicacy and perfection, the objects which reveal themselves to the eye of observation. Such drawings enable

the rest of the world to share in some measure the satisfaction which attends the sight of such objects through the greatest telescopes. They do more: they furnish the means, and, with respect to many things, the only means of determining what changes, if any, time produces in their figure or constitution. The power of delineating with the requisite degree of skill nebulæ, especially, is a high attribute of genius, and has been the gift of a very limited number of astronomers; and accordingly, in such representations, we seldom find any thing like truth and nature; most astronomical drawings are in fact mere caricatures. In regard to nebulæ, the power to delineate well, is hardly less important than the power to observe accurately. Of this power Sir William Herschel set the earliest good example, and Sir John has attained, in the same way, a still higher degree of perfection. Indeed, the figures before us seem in point of precision, delicacy, and general elegance, to be quite unrivalled.

In this department of practical astronomy, embracing both the observation and delineation of nebulæ, our lamented young countryman, Ebenezer Porter Mason, exhibited the highest degree of excellence; and it affords us sincere gratification to find that the illustrious author before us, has not only made frequent reference to the labors of our departed friend, but has evinced, throughout, a candid disposition to do justice to his merits. As some of our readers may not be conversant with the history of this extraordinary youth, it may be proper to state a few particulars respecting his short but distinguished career. Mr. Mason graduated at Yale College in 1839, and died of consumption at the close of 1841, at the early age of twenty-two years. Brief and transient as was the period of life allotted to him, yet it sufficed to give him a name and a place among the astronomers of the age, and to inspire the hope that he was destined to extend the boundaries of astronomical science. He possessed that *assemblage* of qualities which seldom meet in the same individual, but all of which are essential in order to form the great astronomer;—"a *hand* of exquisite delicacy to construct and adjust, and to delineate—an *eye* endued with extraordinary powers of vision to observe—an *intellect* the most profound to follow out all the consequences of astronomical discovery—and that unconquerable *enthusiasm* which is regardless of the loss of rest, of exposures by night, and even of life itself."*

During his second year in college, under the direction of the writer of this article, he made a series of observations on a remarkable cluster of solar spots, which made their appearance in March, 1837, and executed drawings of them, which evinced such power of drawing and such skill in delineating, as greatly to astonish

* Memoir of Mason, p. 222.

the Professor who had lent him the use of the telescope. In the course of the following year, in conjunction with his classmate, Mr. Hamilton Smith, he constructed a fourteen-feet reflector, having an aperture of twelve inches, which was at that time the largest instrument of the kind in the United States. Formidable as this undertaking was, these two enthusiastic young men, in the transient intervals which they could redeem from their appointed lessons, carried the construction to a high degree of perfection; having, with their own hands, cast the great speculum, given it the requisite figure, and imparted to it its final polish. In fact, except a little occasional aid from ordinary mechanics, they may be said to have made all the other parts of the instrument including the tube and the stand. It was an excellent instrument, in most respects, but more especially for the fine light it afforded, a quality which tempted them into the region of the Nebulæ; and having before made themselves familiar with the common celestial objects presented to the telescope, they embarked at once in this most refined and difficult department of practical astronomy. Immediately after the final examination of their class, in the summer of 1839, being now released from the ordinary routine of college duties, our youthful astronomers commenced the laborious observations after which they had so eagerly panted. These were prosecuted during the following year by Mason alone, along with numerous micrometrical measures taken with the Clark telescope belonging to Yale College.

In the article on the Nebulæ afterwards published by Mason in the American Philosophical Transactions, he says respecting their peculiar method of observation, "It consists not in an extensive review, but in confining the attention to a few individuals; upon these exercising a long and minute scrutiny, during a succession of evenings; rendering even the slightest particulars of each nebula as precise as repeated observations, and comparison with varied precautions, can make them, and confirming each more doubtful and less legible of its features by a repetition of *suspicions*, which are of weight in proportion as they accumulate; and, lastly, when practicable, correcting by comparison of the judgments of different persons at the same time."

In the *delineation* of the objects thus carefully observed, Mason adopted also a process of his own invention. It is sufficient to say that in delicacy and beauty, his figures are but little inferior to those of the work before us. For their *accuracy*, we have the authority of Sir John Herschel himself. The nebulæ selected for observation by Mason were from the catalogue of Sir John, published in the Philosophical Transactions for 1833, and were four in number, (*h.* 1991, 2008, 2092, 2093.) They proved, however, to be actually but *three*, for the last two of the series they discovered to be one and the same nebula, united by a long

irregular band of faint nebulous matter. Mason spent most of the following winter in making micrometrical measurements of the principal stars in these nebulæ, and in writing the elaborate article on the Nebulæ, which made about fifty quarto pages in the printed transactions of the American Philosophical Society. It was written under the pressure of indigence and weakness, and the various sufferings incident to the daily advances of a fatal malady, which terminated his life while the article was in the course of publication, and he was even denied the mournful satisfaction of witnessing its completion.

In the work before us Sir John Herschel takes very respectful notice of the labors of Mason; and as it will gratify many of the friends and admirers of this lamented youth, to find the exalted opinions which were expressed respecting him here, confirmed by the highest authority abroad, we will copy the substance of the notices which our author has taken of his researches on the nebulæ. With respect to the nebula situated near the bow of Sagittarius, (*h.* 2008,) after mentioning some circumstances which indicate a change in this object, comparing his latter with his earlier observations, Sir John adds: "Under these circumstances the arguments for a real *change* in the nebula, might seem to have considerable weight. Nevertheless, they are weakened or destroyed by a contrary testimony entitled to much reliance. Mr. Mason, a young and ardent astronomer, a native of the United States of America, whose premature death is the more to be regretted, as he was, so far as I am aware, the only other recent observer who has given himself, with the assiduity which the subject requires, to the exact delineation of nebulæ, and whose figures I find at all satisfactory, expressly states* that *both* the nebulous knots were well seen by himself and his coadjutor Mr. Smith, on the 1st of August, 1839, *i. e.* two years subsequent to the date of my last drawing. Mr. Mason also declares the upper and larger knot to be irresolvable by his telescope, (a reflector of 12 inches aperture and 14 feet focal length, constructed by himself.) In this particular my observations of 1835 and 1837 so far agree, that its resolvability is not mentioned in words or indicated in the diagrams made on those occasions."†

In regard to the nebula in Sagittarius called the *Trifid*, (*h.* 1991,) which was also one of the four described by Mason, Sir John Herschel observes, "that his figure and Mason's agree in every essential particular, with one rather remarkable exception, viz. in the form of the southern mass of the trifid nebula, and the character of the three paths or avenues which lead up to the triple star.

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* Mem. American Phil. Soc., vol. vii, Art. xiii, p. 177.

† In Sir John's description of this nebula, which Mason saw, the part in question was represented as resolvable.

Mason represents these avenues as free from any abrupt change of direction, the northern and the preceding of them branching out with an easy and graceful bifurcation from the southern; whereas my figure, whose correctness in this respect I cannot doubt, gives to the preceding avenue a remarkably sudden and uncouth flexure, like a gnarled branch of an oak, just at its divergence from the other two. The southern nebulous mass, in my figure, has a considerably wider extension towards the preceding side than in Mason's, which represents it as nearly round, but as this portion was very faint, there was probably not light enough in his telescope to render the whole visible." The author adds in a note: "The places of his stars being determined by numerous and elaborate micrometrical measures, are no doubt more accurate than mine." With this testimony to the refined accuracy of Mason's observations, under all the disadvantages he had to contend with, his friends may well rest satisfied, although some slight discrepancies should be found between his delineation of this nebula and that of the great astronomer with which it is compared. Now that so many powerful telescopes are directed to the heavens, we probably may ere long have the means of determining which of the two representations is the more correct.

The great nebula in the Swan, which had been represented by the Herschels as consisting of two distinct formations, Sir John admits that Mason has proved to be one and the same nebula,—a discovery imparting so magnificent a character to this nebula, and, considering all the circumstances, of so high an order of merit, that we are confident, had the author been writing of the northern nebulæ (among which this is found) instead of the southern, he would have given to it more than a passing notice. He also omits to mention, that Mason discovered in the vicinity of the Trifid a nebula before unknown, surrounding the star 22, standing in the relation of a *companion* to the greater nebula.

Astronomers have looked with great expectation to see what account Sir John Herschel would give of those remarkable objects, situated near the south pole, long known under the name of *Magellanic Clouds;* and the laborious and patient attention which he bestowed upon them, and the magnificent figures by which he has represented them, must, we think satisfy the most eager curiosity. The appearance of the "Nubeculæ" to the naked eye, is not as splendid as Sir John had been led to expect, by the glowing descriptions of voyagers in the southern seas. "The general appearance (he observes) of these objects to the naked eye, in a clear night, and in the absence of the moon, (whose light completely effaces the lesser, and almost also the larger of them,) is that of pretty conspicuous nebulous patches of about the same intensity with the Milky Way." But the author has given his readers an opportunity of judging for themselves, having inserted among the

plates, at the close of the volume, full representations of both the greater and the lesser Nubecula, as seen by the naked eye. The telescope, however, makes amends for any disappointment which may have been felt on first meeting with these celebrated members of the southern hemisphere. This noble instrument reveals to us, instead of faint "patches" of light, a wonderful congeries of nebulæ, for the most part scattered here and there without any apparent order, but still presenting, among its subordinate members, marks of symmetry and organization. A large sheet among the plates at the end of the volume, affords us the gratifying spectacle of both the nubeculæ, as seen in the twenty-feet reflector; and fine drawings of the more curious subordinate groups, are also given among the engravings of remarkable nebulæ. The Nubecula Major is situated at an average distance of about 21° from the south pole; but the brightest and richest region of resolved and clustering stars, is situated at about *5h.* 30*m.* in right ascension, and 67° in south declination. The general description given by our author is as follows: "The Nubecula Major consists partly of large tracts and ill-defined patches of irresolvable nebulæ, and of nebulosity in every stage of resolution, up to perfectly resolved stars like the Milky Way; as also of regular and irregular nebulæ properly so called; of globular clusters in every stage of resolvability; and of clustering groups sufficiently insulated and condensed to come under the designation of clusters of stars in the sense in which that expression is always to be understood in reading my Father's and my own catalogue. In the number and variety of these objects, and in general complexity of structure, it far surpasses the lesser Nubecula; some idea of which may be found by comparing the numbers of registered nebulæ and clusters in each. For while in the latter the number of such clusters amounts only to 37, and (taking in 6 outliers, which may be regarded as forming a part of its system) at most to 43, the former contains no fewer than 278, without reckoning between 50 and 60 outliers immediately adjacent, and which may very fairly be regarded as appendages of the nebulous system of Nubecula Major, making an average of about 6½ to the square degree, which by far exceeds any thing to be met with in any other region of the heavens. Even the most crowded parts of the stratum of Virgo, in the wing of that constellation, or in Coma Berenices, offer nothing approaching to it. It is evident from this, and from the intermixture of stars and unresolvable nebulosity which probably might be resolved with a higher optical power, that the nubeculæ are to be regarded as systems *sui generis*, and which have nothing analogous in our hemisphere." p. 147.

The observations on the Nubecula Major were conducted in 34 zones, and occupied a period of four and a half months;

which fact, taken in common with the known industry and perseverance of the observer, gives some idea of the great complexity of these remarkable objects, composing, as they do, an assemblage not of stars but of firmaments. In two tables which follow the description of them, we are presented with the reduced places of 919 stars, nebulæ, and clusters, in the greater, and of 224 in the lesser Nubecula. The author does not consider himself to have completed the survey, but modestly terms his work a first approximation towards a catalogue of objects in the Magellanic clouds.

Although the discovery of new nebulæ, and the more accurate determination of the places of those of the southern skies already known, constituted the principal object of Sir John Herschel, yet he also wisely kept in view certain other subordinate purposes, in order to render his laborious undertaking, and self-denying exile from his country, as useful as possible to the cause of science. Among these objects we find very valuable records of observations on Double Stars, on Halley's Comet, and on Solar Spots. Numerous and important as are these observations on the double stars of the southern hemisphere, yet, comprising, for the most part, such only as incidentally fell in his way while sweeping for nebulæ, the author would have it understood, that the list is not to be considered either as embracing a complete catalogue of the double stars of the southern hemisphere, nor the places assigned as, in general, found with absolute precision. On this subject he remarks as follows: "Bearing these circumstances in mind, it will not be matter of surprise, that the catalogue of double stars, furnished by the twenty-feet sweeps, is comparatively deficient in those of the first, or closest class—meaning by this, stars of which it can be confidently asserted, that the angular distance of the individuals is under two seconds. But independent of such drawbacks, though I have no direct statistical enumeration to bear out an assertion, I cannot help putting on record a strong *impression*, that the extra-tropical part of the southern hemisphere is really poorer in very close double stars than the northern; at least in those regions of it which come to be observed on the meridian in the best season for definition. The almost total absence of objects of this description from the catalogue, in the last six hours of right ascension, is the more striking, as these are precisely the best hours for definition, coming to be observed from June to October, when the atmosphere is in the most favorable condition."

These remarks of the author raise such moderate expectations, that we are somewhat surprised to find, that the number of double stars actually registered in this catalogue, exceeds *two thousand*. The numbering is continued on from the northern catalogue, commencing at No. 3346, where that ends, and ter-

minating at 5542. The particulars respecting each are arranged in five columns, giving, for the epoch of 1830, the right ascension, the north polar distance, the angle of position, the distance of the separate members from each other, and their comparative magnitudes; and, in a broader column on the right, are appended copious remarks on each. Among these double stars, as might be expected, several *binary* systems were detected, indicating, in some cases, a rapid revolution of the members around a common centre of gravity.

One of the most interesting of the binary systems is that of *Gamma Virginis*. Sir John Herschel had previously made this a particular object of research, and predicted the perihelion passage of the smaller star. He had, however, assigned to it too large an orbit, requiring 625 years to complete a revolution, whereas its period he now finds to be only 182·2 years. The first person, so far as we are informed, who discovered that the period formerly assigned must be greatly reduced, was Mr. E. P. Mason. On this subject, our distinguished countryman, Mr. S. C. Walker, remarks as follows: "In an interview with Mason in his short stay in Philadelphia, while on his way to his final resting place in Virginia, he showed me a list of his measurements of the positions and distances of several of the binary systems, (as γ Virginis, Castor, σ Coronæ, &c.) and mentioned that a discussion of all the observations published to the date of 1838, with his own of the spring of 1840, on the graphic method of the younger Herschel, had given him an ellipse of a period of 171 years for γ Virginis; and that the date of 1840·4 with his elements, furnished an angle of position of 25½ degrees. I have since received the Astronomical Notices from Altona, and there find a similar value for the same date, in the measurements of Struve at the great Pulkova Observatory, and of Kaiser at the Leyden Observatory."* In the work before us, Sir John Herschel has the following remarks on this subject. "The apparent perihelion passage of this interesting double star, took place in the first half of 1836, and the appulse of the two stars proved, as predicted, so very close as to cause it to appear as a single star to all but the most powerful and perfect existing telescopes, under the most favorable circumstances. In no part of the interval from 1835·971, to 1837·545, both dates inclusive, was it possible to observe any *certain* elongation of the united disks with the seven-feet equatorial, capable of being, in the smallest degree, relied on for a measure." As an apology for having so much mistaken the period of revolution, our author shows by a diagram that during the period of observation from 1782 to 1835, the orbit of 625 years would in fact almost coincide with the orbit of 182

* Memoir of E. P. Mason, p. 230.

years, "the actual or smaller ellipse being curiously packed within the other, in the manner of an osculating curve, intersecting it in four points, and deviating from it in the intervals between them by a quantity much too small to excite any suspicion of error at that time." The period assigned by young Mason, (171 years,) differs only 11 years from that now given by Sir John Herschel; but the estimates of different astronomers have varied from 124 to 196; and Maedler (whose observations on this binary system are especially confided in) gives the period of 148·78 years. The mean of the results obtained by Herschel and Maedler is 165·5, differing only $5\frac{1}{2}$ years from the period assigned by Mason.

The finest star of the southern hemisphere is *Alpha Centauri*. "This superb star, beyond all comparison the most striking object of the kind in the heavens, and to which the discovery of its parallax by the late Professor Henderson, has given a degree of astronomical importance no less conspicuous, consists of two individuals, both of a high ruddy or orange color, though that of the smaller is of a somewhat more sombre and brownish cast. They constitute together a star which to the naked eye is equal to or somewhat superior to Arcturus in lustre. In the 20 feet reflector it was 'truly a noble object,' its image could be distinctly seen through good superfine drawing paper, and at four feet from the eye-piece, it showed on the paper seen in front (by reflected not transmitted rays) a superb double star."

But our limits will not allow us to attempt a complete exhibition, of the astronomical riches of these comparatively unexplored regions. We must content ourselves with a very brief notice of the remaining chapters. The *third* chapter treats of *Astrometry*, or the numerical expression of the apparent magnitudes of the stars,—a subject which well deserves the attention of practical astronomers, since the want of a perfectly uniform and precise method of determining the comparative magnitudes of the stars, is universally acknowledged. But we are compelled to omit, for the present, any attempt to exhibit Sir John Herschel's peculiar views in relation to this subject.

Chapter fourth presents us with a most interesting view of the *distribution of the stars* in the southern hemisphere. It was no small object with Sir John Herschel to ascertain whether the views which his illustrious Father had originated respecting the constitution of the Galaxy, derived from observations on the northern heavens, were corroborated by similar observations on the southern. It is well known that as early as 1785, Sir William Herschel announced, in the Philosophical Transactions, as the result of extensive "gauges" of the heavens, that the comparative abundance or scarcity of stars in any particular region of the northern hemisphere, and of the southern, so far as they

are visible in those latitudes, has reference to its situation with respect to the Milky Way; the numbers contained in a given space, as a quarter of a degree, rapidly increasing as we approach this zone on both sides; and that the visible firmament of stars belong to and form part of a vast *stratum*, or considerably *flattened* and unsymmetrical congeries of stars, in which our system is deeply, though excentrically, plunged, being situated near a point where the stratum divides itself into two branches. Pursuing a similar investigation in the southern hemisphere, Sir John Herschel made 2300 gauges, embracing so many distinct fields of view, and comprising 68948 stars actually enumerated. In conformity to what had been observed by his Father, he found the average number of stars at points most remote from the Milky Way, only 6 in a field, while, in the immediate vicinity of the Milky Way, the average number is 59, and the rates of increase from one extreme to the other is nearly uniform. This induction corroborates, most decisively, the inference of Sir William Herschel, that *the stars of the visible heavens, are all arranged with reference to the Galaxy.* From both sets of observations it is inferred, that the number of stars, of both hemispheres, visible enough to be distinctly counted in the twenty-feet reflector, is 5½ millions. But our author thinks that the actual number is much greater than this, for large tracts of the Milky Way are so crowded as to defy counting the gauges, by reason not of the smallness, but of the number of stars.

The observations of Sir John Herschel on *Halley's comet*, which are given in the fifth chapter, suggested to the author some new and peculiar views respecting the nature and constitution of comets in general. His curious observations on this wonderful body after it had passed its perihelion, have already been communicated to the public through the scientific journals. Four things were especially remarkable. First, the rapid dilatation of its visible dimensions. On one occasion a difference of dimensions was observed amounting to 14″·7 in two hours and a quarter. Indeed, so rapid was the augmentation of volume that *the comet might almost be said to grow.* Secondly, the preservation of the same regular geometrical form of the distorted and dilating envelope; thirdly, the rapid disappearance of the coma; and fourthly, the increase in density and relative brightness of the nucleus.

The concluding chapter gives a series of observations on the remarkable clusters of *Solar Spots*, which appeared on the Sun's disk in the years 1836 and 1837. Of these Sir John took accurate drawings, thirteen of which are inserted among the engravings at the end of the volume; and he retains the rest, and annexes a list of them, in case it should ever be considered necessary to appeal to any of them as records of the state of the Sun's surface at that time. We are happy to find among the list (though

not among the *engraved* specimens) observations corresponding to those made by young Mason, on the remarkable group which appeared in March, 1837, (to which reference has already been made,) drawings of which are in our possession on a scale more magnificent, and not inferior in beauty, nor, as we believe, in accuracy, to those figured by the illustrious astronomer whose work we have thus hastily and imperfectly reviewed. We take our leave of it for the present, with a grateful conviction that it constitutes a grand and noble advance in our knowledge of the starry heavens.

ART. XV.—*On a law of Cohesive Attraction, as exemplified in a Crystal of Snow;* by JAMES D. DANA.

IT is a general fact that the most common objects or occurrences about us, best illustrate the great laws of nature. The ordinary forms of crystal present to the student, as we have shown, a large part of the laws of cohesive attraction,* and to perceive and appreciate them requires only an attentive enquiring mind. The subject of crystallization, cannot long be left to the mineralogical text-book and mineralogist; for it is the great source of knowledge respecting a fundamental power in the physical world. We add to our former deductions, a principle for which we are indebted to a crystal of snow. The cleavage of crystals indicates, as before explained,† that the force of attraction is intermittent in action, and therefore produces seriate results, precisely as intermitted reproduction causes seriate results in the organic kingdom, giving layers to wood, successive ranges of parts to many plants and animals, and, generally, alternate action and comparative inaction in growth. This intermitted action in the cases referred to, is an essential quality, specific in each case; for the resulting characters are the characteristics of a species. The crystal of snow here figured, illustrates a kind of intermittent action dependent on extrinsic circumstances. It is a figure of a minute star from an ordinary flake of snow, and is often to be seen in the course of a winter. The great number of different forms figured by Scoresby,‡ are evidence of the variations of action in the attraction which extrinsic causes produce, for no two different forms could have resulted from exactly the same exertion of that force.

* Last volume of this Journal, page 364.
† Ibid, page 378.
‡ Edinburgh Encyclopedia, Plate 503.

In the case before us, each of the six rays has a series of short crystals along the margin, producing what Botanists call a *pinnate* form.

As the crystal enlarged, these branchlets were formed at intervals by twos. There was an interval in which the sides of the ray produced no branch; and then another where a branchlet began on either side; and so on successively, as the crystal indicates.

The moment of production for the six rays severally was the same for each, for there are corresponding branchlets on each, at the same distance from the centre.

The interval between the successive productions was equal; for the branchlets are the same distance apart.

The rate of increase corresponded in each parallel series, for the branchlets at equal distances from the centre are equal.

Hence, *the action of the attracting force was in some degree regularly and uniformly intermittent.*

Again we observe that the branchlets are equal throughout instead of being longer towards the base of each ray, where they were first formed. As the ray increased at the extremity, it produced its lateral branchlets after attaining a length beyond a former branchlet equal to the interval separating two branchlets. And the branchlet produced, increased for a certain period of time, till a specific length was attained, and then ceased to enlarge. Thus growth took place at the extremity according to a regular law of intermission. The extremity elongating, produced its pair of lateral branchlets, after a certain interval, while parts of the star nearer the centre did not increase; or they increased so equally throughout, that a perfect uniformity in size was retained. Hence the attracting force was most active at the extremity, and its condition of activity determined the length of interval between the successive side-developments. In other words:—

The *force of attraction was active only for a limited distance from the apex of each ray; its action was apical alone, until the extremity had increased to a definite length, and then lateral action ensued, producing on each side a branchlet; this length of interval was a fixed quantity for the crystal.*—Hence the intermitted result and its uniformity. The limited distance from the apex to which the force is in a state of activity, may perhaps determine the length of the side branchlets.

From the various figures given by Scoresby, many variations in the condition of this force are readily deduced; we do not enter fully into this subject, as we should prefer first to verify his figures. The general fact however is too plain to be mistaken.

With a different condition in the force at the extremity, and in its relation to that in the sides of the rays, a hexagonal plate may result instead of a star; the condition should be such that there would be laterally a continuous instead of intermittent increase of the rays.

When the action was but slightly intermittent, a hexagonal plate might result with concentric striæ. The striæ of crystals have generally this intermittent origin, and with it is often connected a consentaneous intermittent action in the cause of secondary planes, as alluded to on page 379 of the last volume of this Journal. The striæ on the hexagonal compound plates of chrysoberyl are evidently of this character. The horizontal striæ on some elongated prisms of quartz are of the same origin. And we remember no instance of striæ that are not accounted for by the causes here presented.

After a star has begun, its rays are sometimes terminated by hexagonal plates, showing that the variations of force alluded to may occur in the same crystal, according as it is exposed to different external circumstances. Various other points might be touched upon; but these are sufficient to illustrate the general principle in view.

The facts elucidate generally the mode of action in attraction, by which the relative length and breadth of an enlarging prism are determined.

The correspondence between these facts and the results of growth is too striking to be overlooked. The production of lateral branchlets to a branch of a plant at certain intervals from the extremity, and various facts in the forms assumed by the results of organic developments, have evidently a common law of origin with the character of the crystals alluded to. This point is dwelt upon by the author in his work on Zoophytes.* We thus see that both vital and physical forces operate according to a single general law, and the fullest demonstration is before us of the unity of plan throughout created existence.

ART. XVI.—*Proceedings of the Meeting of the Association of American Geologists and Naturalists, held at Boston, September*, 1847.†

1. *Notice of five new species of Fossil Mammalia from Illinois;* by JOHN L. LECONTE, M.D.—The fossils which form the subject of the following notice, were found in the lead region of Illinois, by Mr. Wm. Snyder of Galena, by whom, with the utmost liberality, they were presented to the author. The exact geological period to which they belong is not known, as they were not found *in situ*, but in a crevice fifty feet below the surface; this crevice was filled with a mixture of clay and sand cemented by oxyd of iron, into a hard mass, which cannot be entirely removed without great injury to the specimens.

* Report on Zoophytes, 4to, pp. 85–100.

† The following abstracts, excepting the one on heat, have been furnished by the authors.

This small collection is interesting, as exhibiting several forms of Suiline, and Tapiroid Pachyderms, the former of which group, was heretofore entirely unrepresented in our fossil fauna: of the latter only a single species was known, the *Harlanus americanus* Owen, (Sus americana, Harlan.) Bones of a small Pachyderm, considered identical with Tapirus americanus have been dug up in Texas and Louisiana.*

The first of the species mentioned by Dr. LeConte, was named *Platigonus compressus:* the generic name being derived from the curious dilatation of the angle of the inferior maxilla, which is produced into a large and broad expansion, concave outwards. This peculiarity among existing mammalia has been observed only in the Hippopotamus, and in that animal in a much less degree than in the present genus. The cranium is very narrow and elevated; the superior canines are compressed, acute, and slightly curved, they are directed forwards and downwards, so that they were entirely concealed by the lips, as in Tapirus, Lophiodon, &c., the edges are almost acute, the external face slightly more convex than the inner, and marked near the base of the exserted portion with an acute oblique elevated line which is met on the anterior edge by a similar less elevated one belonging to the internal surface. This second line is angulated at its basal extremity, and there unites with a third line, almost parallel with the anterior margin. This margin is a little worn for one half the length of the exserted portion. In the superior maxilla, there are three premolars, followed by three molars: the first premolar is triangular, with an internal tubercle surrounded posteriorly, externally and anteriorly, by a broad basal margin: the second premolar is slightly transverse with a large transverse ridge, divided by an antero-posterior impression into two cusps: the posterior basal margin is broader than the anterior, and the external margin is very narrow. The third premolar is like the second but larger and not narrowed internally. The first and second molars are quadrate, with two large transverse ridges, each divided by an antero-posterior impression; there is a strong anterior, external and posterior basal margin: the anterior and posterior margins are slightly elevated in the middle, and more closely connected with the transverse ridges by slight elevations, which run obliquely inwards. There is no internal basal mar-

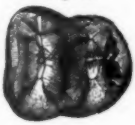
Fig. 1.

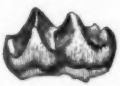
Inner view, supposed canine.

* Hoc op., vol. xlii, p. 390: ibid, ii ser., vol. ii, p. 247.

gin, except at the expansion of the valley. The third molar is similar to the others, but larger and sinuate on the sides, the posterior part is rounded, and the basal ridge posteriorly rises into a small acute cusp, connected with the internal pyramid of the posterior transverse eminence. Of the inferior teeth, only the second and third molars are preserved. The anterior of these is quadrate with two large transverse ridges separated by a deep valley. The anterior and posterior faces have an obsolete basal margin connected with the transvere ridges by a slight elevation, running obliquely outwards. The last molar is elongate, narrowed and rounded posteriorly with two transverse ridges as in the second molar; it has a very obsolete anterior basal margin, and a large posterior undivided talon, as much elevated as the two ridges: this talon is separated by a valley quite similar to the valley which separates the two principal ridges.

Fig. 2.





Inner view.

The humerus of this animal is perforated at its distal extremity by a large round foramen: this bone, the cubit, vertebræ, &c. will be more fully described in a paper illustrated by figures, which the author is now preparing for publication by one of our learned societies. In this paper also the affinities of this and the other proposed genera will be pointed out in detail.

The second animal belongs to the Suiline group and was described as a Dicotyles; the author being now convinced of its generic difference, proposes the name *Hyops depressifrons*. It is distinguished from Dicotyles, by the very depressed cranium, the nasal bones being very slightly curved transversely in the arc of a circle, while in Dicotyles the sides are nearly perpendicular. The part of the os frontis between the frontal grooves is less elevated than the part adjoining the orbit; in Dicotyles they form nearly one plane; the frontal foramen is placed half an inch behind the transverse line joining the anterior margins of the orbits; in *D. torquatus* the foramina are situated on this line; the malar bones are very broad and directed downwards, instead of being nearly perpendicular as in *D. torquatus*. The orbit of the eye is deeper, larger and directed upwards and outwards. Behind the frontal foramina on each side is a large round shallow impression: the suture between the nasal and maxillary bones crosses the prolongation of the frontal groove, which remains superior, while in *D. torquatus* it becomes lateral. The canine of the lower jaw is very similar in form and size to that of D. torquatus, from which it differs in having the anterior margin much less acute, while the lateral grooves, (rudimentary in D. torquatus,) are very distinct. The femur, innominatum, humerus, astragalus and some other bones of the foot, resemble closely the corresponding bones of Sus scrofa; they will be described and figured hereafter.

The third species mentioned is also the type of a new genus of Suiline Tachyderm. It was called *Protochœrus prismaticus:* only the first and third molars, and a canine, all from the lower jaw, have been found. These teeth are from a locality fifteen miles distant from the place where the other bones were obtained.

The canine (left lower) is curved, and almost pointed; the posterior face is worn flat, the line separating the worn from the unworn portion is oblique as in Dicotyles; the external and internal faces are slightly convex, and but little narrower than the posterior face; they meet in well defined angles, the anterior edge being scarcely rounded. Near the alveolar margin, on the anterior part, and extending on to the adjoining faces, is a deep space concave in a longitudinal direction, which appears to have been worn, by some agency unknown to the author. It bears some resemblance to the figure of a united fracture of a Hippopotamus tusk, (Owen, Odont., pl. 142., fig. 2.) The enamel is very brilliant on the external and internal faces; on the posterior face it has been worn off. The portion that remains of the inserted part of the tooth is nearly elliptical, the anterior part being flattened, and very slightly impressed; there is also a slight impression on the inner surface. The first molar is quadrate; the crown is much worn, but presents remains of two large transverse elevations, slightly connected in the middle, but without any accessory tubercle; the anterior and posterior parts have strong basal margins each connected in the middle with the adjacent ridge by a slight elevation. The intervening valley has a low angulated external margin, which does not extend on to the transverse ridges. The last molar is fractured, and the anterior lobe is almost destroyed, but enough remains to show that it was similar to the second lobe. The tooth is elongate, narrowed, and subacute behind: it is divided by two very deep transverse valleys, into three large lobes: the anterior and middle of which are divided by a longitudinal impression into two cusps: there is no accessory tubercle; the internal anterior, and external posterior cusps are prolonged towards each other by low elevations, separated by a deep line: between these two lobes is a rough internal interspace, and a larger more elevated external one, which is prolonged posteriorly to meet a large posterior lobe, divided by an oblique line into two unequal cusps, the internal being the larger and more elevated: this dividing line is a prolongation of the same line which divides the other lobes, the tooth is remarkable for the thickness and lustre of the enamel: the anterior and middle lobes are worn in such manner as to present plane faces meeting in well defined lines, like the edges of a crystal.

The affinities of the animal are rendered apparent by the foregoing description; from the form of the canine, it must be

placed with the Chœropotamidæ; from all the known genera of that small family it differs in having no accessory tubercles on the molars: the posterior molar has a larger third lobe than either Chœropotamus, or Dicotyles; and agrees somewhat with the figure and description of the corresponding tooth of the Anthracotherium (Owen, l. l., pl. 135, fig. 10); though never having seen a specimen of the last named animal, I know not if the Protochœrus exhibits any tendency towards the Hippopotamidæ.

The author then alluded to a new species of Racoon, *Procyon priscus*, of which several teeth and phalanges had been procured. The differences between this and *P. lotor* are very minute, and would not be intelligible without plates.

The last genus was known only by a single tooth represented in the accompanying figure, and supposed to be a superior left canine; it is very much flattened; the external surface is regularly and slightly convex; the internal face is concave, with an impressed longitudinal line in the middle; this surface has several small cusps as in the figure.

Fig. 3.

Inner surface.

From the appearance of this tooth, the author believes it to have belonged to a large insectivorous animal, allied to Scalops; the only teeth resembling it being found in the family of the Talpidæ: the author has seen some canines in the American genera of this family, which have the cusps arranged in a similar manner, but none have been seen so much compressed; and in none does the fang of the tooth retain its flattened form for so great a distance. We anxiously await the light which will be thrown on the affinities of this animal, by farther explorations, at the same locality.

In the mean time, as a slight acknowledgment for the favor which Mr. Snyder has conferred upon science by collecting and preserving with much pains the interesting specimens which have given rise to the present communication, it is but proper that the last mentioned species should be dedicated to him, under the name, *Anomodon Snyderi*.

In conclusion the author returns his acknowledgments to Prof. Agassiz, for the numerous suggestions, with which he has favored him, and without which the affinities of the Dicotyloid animal described above under the name of Hyops depressifrons, would have remained in complete obscurity.

2. *A new species of Troglodytes;* by Prof. Jeffries Wyman.—Dr. Wyman exhibited four crania and some of the other portions of the skeleton of a new species of Troglodytes, (*T. gorilla*, Savage,) recently discovered by Dr. Thos. S. Savage in the Mpongwe country on the Gaboon river in Africa. This species differs from the *Enché-eco*, or *T. niger*, Geoff., the only other Troglodyte hitherto described—1, in its much greater dimensions; 2, in the

existence of a large crest in the males on the coronal and occipital region; 3, in the form of the anterior and posterior nasal orifices; 4, in the existence of a notch on the edge of the hard palate; 5, in the comparative length of the ulna and humerus; 6, in the configuration of the pelvis; in the two last peculiarities, it is the most anthropoid of all the Orangs.

A full description of its external characters and habits was read, the facts stated having been carefully collected by Dr. Savage when in Africa.

3. *On the supposed identity of Atops trilineatus with Triarthrus Beckii;* by S. S. HALDEMAN.—Since the publication of Professor Emmons's work on the Taconic System, there have been several discussions relative to the views offered in that work; and at the last meeting of the Association in New York, when the subject was again brought forward, an argument was drawn from the supposed identity of the above named trilobites. A committee was then appointed to investigate the question, and the present report is offered as the result.

The specimens submitted for examination, are both imperfect, particularly that of Atops, so that it is impossible without better materials, to institute a rigid comparison between them, or even to determine the genus of the latter. Moreover, the proper external surface in the Atops seems to be wanting; and but four abdominal segments remain. The comparison is thus restricted to these segments, and the cephalic shield. The outline of these portions taken conjointly, nearly corresponds in the Triarthrus to a square, and in Atops to a transverse parallelogram the sides of which are nearly in the proportion of 4 to 5. The medial lobe of the shield in the former has impressed lines converging backwards, whilst the traces of these in the latter are transverse. The following table presents the comparative characters afforded by the two specimens.

TRIARTHRUS.—*Shield* regularly semicircular; *breadth* twice the length; *medial lobe* the widest; *lateral lobes* with the base much the shortest.

Abdomen: medial lobe widest; *lateral segments* curved and compound.

ATOPS.—*Shield* a smaller transverse segment; *breadth* twice the length; *lobes* equal in width; *lateral lobes* approximately equilateral.

Abdomen: lobes equal in width; *lateral segments* transversely rectilinear.

The characters here cited are deemed sufficient to establish two species of trilobites upon the specimens under examination, the point which the Association desired to have determined; and if the solution now offered is correct, Atops trilineatus remains a fossil characteristic of the strata investigated and named by Prof. Emmons.

Both specimens are quite flat and the pressure having been apparently nearly equal in each, this has not been taken into account in deciding the identity, for although the form of the shield might have varied, the relative width of the bodies would not have been materially altered.

Future observation must determine how far these species may approximate through the respective varieties.

4. "*An attempt to discover some of the laws which govern Animal Torpidity and Hibernation;*" by Prof. PETER A. BROWNE.—Prof. B., after explaining a few technical terms, presented the Association with a table of the animals which become torpid so far as is yet known to Natural History. He then proceeded to examine the phenomena of this extraordinary state, under the following heads. 1st, the respiration of torpid animals; 2d, their circulation; 3d, their digestion; 4th, their secretions; 5th, their organs of relation; 6th, their organs of respiration.

Prof. Browne argued that there was a total extinction of respiration in perfect torpidity, and hence, the state was neither that of life nor death; but a third intermediate state.

5. *A Remark on the Geographical Distribution of Species;* by Prof. C. B. ADAMS.—In illustration of the principles of distribution of species as connected with climate, so ably enforced by Prof. Agassiz, it was stated that four hundred species of Mollusca were found in a small part of the island of Jamaica in a few weeks; that one-fourth of these were land shells, of which new species were found by the collector with every ten miles travel. As a remarkable example of the difference of *station* of different species, a small salt pond on the peninsula of Port Royal was described, in which *Cerithium atratum* occurred very abundantly from the margin to eighteen inches depth, where *C. literatum* commences and extends to three feet in depth. Although the two species approximate to contact at the zone of eighteen inches in depth, they do not intermingle.

6. *On the Taconic Rocks;* by Prof. C. B. ADAMS.—The north part of Addison county, Vermont, possesses peculiar advantages for the study of the so-called Taconic rocks, since here they pass from a highly metamorphic to a slightly metamorphic condition and have been much less disturbed. Some of the typical Taconic rocks disappear, or more probably pass gradually into rocks of the Lower Silurian system.

One of the most conspicuous of the rocks of this region, is a red sandrock, which Dr. Emmons regards as at or near the base of the New York system, but which overlies the Champlain Division, in the order of red sandrock, Hudson river shales, Utica slate, Trenton limestone, and La Motte limestone.

A section was exhibited of Snake mountain, in which these rocks appear by an uplift with their relative position unaltered.

The two lower formations are identified by their appropriate fossils, which occur abundantly; the Utica slate by its position and lithological characters; the Hudson river shales by the same characters, and by their upper member, which is an argillaceous limestone containing the stinted forms of *Chætetes lycoperdon*, which are usual in this the last period of the existence of the species. The red sandrock lies upon the last named rock in actual contact, with a moderate easterly dip. The upper part of this section is repeated in the line of the strike in several other localities, but one only, Buck mountain, three miles north, has sufficient elevation and steepness to exhibit the lower part of the series.

The assertion which had been made, that there is a line of fracture high up the side of the mountain, above the Trenton limestone, was shown to be entirely unsupported by any facts. Not only is there no evidence that such a line of fracture has brought up the shales from beneath the Trenton limestone, the fossils in the upper member of the shales prove that the present is their original relative position. But these shales are the Taconic slates of the Taconic system.

From position, therefore, it is inferred that the red sandrock is more recent than any of the Champlain Division. Its fossils afford less demonstrative evidence. With the exception of *Fucoids* they are rare, having been found only at Highgate, where fragments of the shields of trilobites, having some resemblance to Conocephalus, occur very abundantly, and Atrypa hemispherica (?) very rarely. These fossils, especially the latter, if correctly identified, indicate the period of the Medina sandstone and Clinton group, regarding these two rocks as belonging to one period.

It was also shown by a section from Lake Champlain to the Green Mountains through Ferrisburgh and Monkton, that the Taconic quartz rock is probably a metamorphic equivalent of the above named red sandrock. In this section there is a gradual change in the lithological characters from the red sandrock to the quartz rock; the difference in the lithological characters, however, is only such as must have been the effect of igneous agency in the eastern part of the section, and the order of succession of the calcareous over the quartzose members is identical in both rocks. But since a small part of the section, on the opposite sides of which the change of characters is most conspicuous, is concealed by drift, the identity of the Taconic quartz rock with the Medina sandstone was not positively affirmed.

A section from Buck Mountain through Waltham into New Haven was exhibited, which rendered it somewhat probable that the Stockbridge limestone of the Taconic system is the equivalent of the calcareous rocks which overlie the red sandrock, rather than of the lower limestones of the Champlain Division, as has been commonly supposed.

In reply to Dr. Emmons, [an abstract of whose remarks on the Taconic system we have not received,] it was stated by Prof. Adams that he (Dr. E.) had misunderstood the description of the calcareous rock over the Hudson river shales, which was not affirmed to be the Trenton limestone, but an upper member of the Hudson river shales, as proved by the contained fossils in connection with the position. The remarks of Dr. E. being based on this misconception of the statements actually made, could not of course affect the conclusion respecting the age of the rocks of Snake mountain.

7. *Observation on a Polished Rock;* by Prof. C. B. Adams.—The outline of a shelving rock in the valley of the Winooski, Vt., shows that the rock had been struck on the perpendicular west side, and well rounded and polished as far as the summit, leaving the east as the lee side not acted on. The shelving part also on the west side, which is beneath and within the perpendicular tangent to the surface, is also destitute of any marks of drift agency, thereby proving that the agency was that of a *solid* body.

8. *Claystones;* by Prof. C. B. Adams.—A series of claystones was exhibited in illustration of the remarks made on concretions in the Second Annual Report on the Geology of Vermont. No attempt was made to describe the ultimate law of molecular attraction by which they are formed, but it was shown to be a subordinate law that the attraction is in the direction of the radii of a sphere towards the centre.

9. *On the Remains of Marine Shells of Existing Species found interspersed in deep portions of the hills of Drift and Boulders in the heights of Brooklyn, on Long Island, near New York City;* by W. C. Redfield.—These remains had long since attracted the attention of Dr. Mitchill and other naturalists of the vicinity, but the true character of the formation and the peculiar positions in which the shells were found, were not distinctly known to geologists.

It fortunately happened that M. Desor and Count Portals, while on a visit to Brooklyn a few months since, discovered fragments of these remains in the great masses of boulder drift in South Brooklyn, through which the new streets are being excavated. At their invitation Mr. R. had examined the place, in company with Prof. Agassiz, and had obtained a variety of specimens which were found at depths varying from twenty-five to forty feet below the original surface of the hills in which they were imbedded.

Since that occasion Mr. Redfield has found similar remains in these hills, about two miles northward from the first locality, and has collected numerous specimens which he exhibited to the meeting, together with samples or fragments of the original beds inclosing these shells, which had been dispersed by the drift and

thus lodged in the Brooklyn hills. The number of species comprised in the collection, amounts to ten or twelve, among which are those now most common to our shores.

These discoveries in regard to the drift appear to agree with those which Sir R. Murchison states to have been found in the drift of Europe. They must be admitted as proving that the most common species of our present Mollusks were of prior origin to the hills where the remains were found, and probably older than the entire formation of drift and boulders which is found in the Northern States. The species obtained are not such as indicate a colder climate than now prevails. But the shells found by Prof. Emmons and others in the Pleistocene clays on the borders of Lake Champlain, and by Mr. Lyell and others in Canada, appear to belong to a later period of the drift, and Mr. Redfield infers that they were brought in from more northern regions or from deeper waters, by the great arctic currents which must have swept over these regions during the drift period, when this portion of the continent was deeply submerged. These polar currents annually freighted with immense fields and islands of floating ice, such as are now diverted along the shores and banks of Newfoundland till they are met by the dissolving influences of the Gulf Stream nearly in the latitudes of Boston and New York, he considered to be among the chief agents in producing the remarkable phenomena of the drift period.

10. *A Section of the Coal Seams and accompanying Measures of the Hazelton coal basin in Luzerne County, Penn., as an illustration of the construction and coloring of Geological Sections;* by Prof. W. R. Johnson.—It is most commonly impracticable to take measurements diametrically across the strata, or at right angles to the plane of stratification: but yet for many theoretical and practical purposes, an easy and correct method of determining the thickness of a series of stratified rocks is very important. To compute thickness from observations of *level, inclination, direction of dip*, and *measures of distance*, presupposes that the survey is restricted to limits within which the *dip, strike*, and *thickness* are essentially constant. On the borders of the ocean or other tide waters, on the artificial cuttings for railroads and canals and even along the margins of many rivers and ravines as well as in horizontal mine-tunnels, the measurements may be generally made independent of the use of leveling instruments. In such cases the compass, tape-line and clinometer suffice to give the *horizontal distance* from one member to another in the series, together with the inclination and direction of beds.

When the horizontal measured line is oblique to the direction of dip, the degree of this obliquity may be represented by o, the inclination by i and the measured distance by d. Then calling e the thickness of beds traversed, we have,

$$e = \sin i \times \cos o \times d.$$

When the measurements are taken, not on a level, but over an inclined or undulating surface, the operation of levelling, determines the position of the line connecting the extremities of the section, with reference to a horizontal line in the same vertical plane, reaching from the higher to the lower bed of the series. The length of this horizontal line also becomes known, since the dip of the beds is supposed to be ascertained, and the quantity *d* thus computed, enters the formula as before. It is evident that this determination of the *horizontal distance* here admits of two cases, according as the *underlying* or the *overlying* bed is topographically the more elevated at the outcrop. In the former case the *horizontal* is shorter, and in the latter longer, than the *inclined* line of measurement.

Prof. J. mentioned that the section which he exhibited had been constructed in the manner above explained, and that specimens of rock, coal, slate, &c., collected from point to point along a tunnel driven obliquely to the place of dip had been used to furnish the coloring materials, appropriate to the respective parts of the section.

Having marked out the limits of each bed, a moderately thick paste of gum tragacanth and gum arabic in equal parts, is spread over one of the spaces required to be colored, and is not allowed to extend to the next. The pulverized rocky material is then sifted over the surface till the paste is completely covered. The excess is then thrown from the sheet, and the adjoining spaces are successively coated in a similar way with their appropriate powders. To exhibit coarser and finer materials in the same rock, a coarser sieve is first used to sprinkle sparsely a quantity of granules over the paste; the finer powder is then applied to occupy the intermediate spaces. Conglomerates belonging to the formation represented, were thus exhibited on the section. When all the colors have been applied and time allowed for drying, a coat of pure map-varnish is applied to prevent injury to the surface from rolling or transportation. This precaution is unnecessary when the section is to be permanently suspended.

Prof. Johnson also called attention to some facts in the natural condition and artificial production of gypsum. Adverting to some remarks during the present session on the calcareous deposits in steam boilers, he exhibited specimens of scale from a sea steamer's boiler accumulated during a run of sixteen hours over the Bahama banks. It is crystallized in prismatic fibres crossing the thickness, and has a sp. gr. of 2·69. Analysis proved this scale to be a dihydrated gypsum composed of

Lime,	39·67	2	atoms,
Sulphuric acid,	54·25	2	"
Water,	6·07	1	"

and consequently corresponding in composition with crystals,

also found in a steam boiler and analyzed by Prof. Johnson of Durham.

As the boilers in which the scale was collected do not probably use pressures exceeding fifty pounds per square inch, the temperature must have been under 300° Fah.

In a geological point of view the observation possesses interest, as it indicates in the water at different parts of the ocean, variable proportions of sulphate of lime, due probably to the same causes which in earlier periods occasioned so very unequal a distribution of gypsum in different parts of the earth and even of the same country.

It may also possibly have a bearing on the temperature of the earth or ocean at the time when the different sulphates of lime were deposited. These have commonly been divided into hydrous gypsum and anhydrite, but that the latter is not always destitute of water is proved by several facts.

The statement of Dr. Beck was referred to as showing that the anhydrite of Lockport, New York, "contains sometimes a considerable proportion of water."

A specimen of anhydrite from the East River of Pictou, Nova Scotia, had yielded Prof. Johnson essentially the same composition as the boiler scale, viz.,

Lime, - - -	39·40	-	2 atoms,
Sulphuric acid, - -	54·70	-	2 "
Water, - - -	5·90	-	1 "

while a specimen of fibrous gypsum from Plaister cove, Cape Breton, had given,

Lime, - - -	32·9	-	1 atom,
Sulphuric acid, - -	46·3	-	1 "
Water, - - -	20·8	-	2 "

[Prof. W. B. Rogers remarked that the gypsum in the southern part of Virginia, in the salt region of that state, was all of the same character as that of East River of Pictou, and of the boiler scale, containing two atoms of sulphate of lime to one of water.]

Prof. Johnson referred to the fact stated by authors, that in certain parts of Switzerland, particularly at Bex, canton of Berne, the masses are formed by hydrous gypsum to a certain depth and below that of saccharoidal anhydrite.

He also referred to the fact, that common hydrous gypsum heated to more than 300° is afterwards incapable of absorbing water so as to "set" in the process of stuccoing. This renders it improbable that true anhydrite has been converted into common gypsum by the action of water.

11. *On Heat;* by Prof. HENRY.—Prof. H. showed the analogy between light and heat, by stating that as two rays of *light* might be so opposed as to produce *darkness*, so two rays of *heat* might be so opposed as to produce *cold*. The facts with regard to heat

as well as light therefore show that the theory of undulation is not an imagination, but the expression of a *law*. The minimum of heat, as proved by his experiments with the thermo-electric pile, does not correspond with the minimum of light. Among flames, there are many which give but little light, but which give great heat; as, for example, the flame of hydrogen. The amount of radiant heat and radiant light were found to be about the same.

The spots on the sun are colder than the surrounding surface; and its surface is variously heated. This result he obtained by a very simple experiment of throwing the disc of the sun on a screen, and placing the very sensitive thermo-electric pile before its different parts. He had not yet concluded his experiments on the sun, and had not measured the comparative heating powers of the centre and circumference, from which results very important consequences would be drawn.

This apparatus he fitted to a common pasteboard tube, covered with gilt paper externally, and blackened internally, with which he measured the heat of distant objects. He could detect the heat of a man's face a mile off; that of a house, five miles off. He thus discovered that the coldest spot of the sky is at the zenith. One day, on directing his tube to a cloud, from which flashes of lightning proceeded, he was astonished to find it indicated a great degree of *cold*; he afterwards found out that a considerable quantity of hail had fallen from this cloud.

He was not satisfied with the appearances of heat supposed to have been derived from the moon. The heat that other observers have got, is probably the reflected heat of the sun, and not the moon's proper heat.

12. *On the Absorption of Carbonic Acid by Water, Saline Solutions, and various other liquids;* by Prof. W. B. Rogers and Prof. R. E. Rogers.—In an oral abstract of this paper, Prof. W. B. Rogers stated that the researches to which it referred had been entered upon nearly a year ago by himself and Prof. R. E. Rogers, according to the methods employed by Dalton and Saussure, but from the irregularity of the results incident as they found to these modes of operating, they were led to relinquish them after much unsatisfactory labor. In the more perfect process, afterwards adopted, the determinations were uniform and consistent, seldom giving a variation in successive trials of one per cent. The apparatus employed, of which a figure was exhibited to the Association, is so constructed as by a peculiar connection to enable the operator to agitate the liquid with the gas while the tension remains unaltered. The absorption is measured by a column of mercury in a fixed tube of syphon form, connected with the flask in which the agitation is given by a vibrating motion. The flask and measuring tube, as well as the gasometer supplying the

CO_2, are maintained at a common and permanent temperature during the process by immersion in a large volume of water.

This operation even with the most *sluggish absorbents* is completed in a short time and thereby various sources of error are avoided.

The absorption of CO_2 by pure water was determined at successive temperatures from 32° to 100°, and a curve constructed representing the law of absorption as dependent on temperature. This the authors regard as the first systematic investigation of the influence of temperature upon absorption, yet made known.

In the case of other liquids, the experiments were for the most part restricted to the temperature 60°, all the liquids being first freed as completely as possible from air.

The following is a list of the substances which had thus far been subjected to experiment.

Water, alcohol, sulphuric ether, acetic acid, several oils, common and Nordhausen sulphuric acid, hydrochloric and nitric acid, saturated solutions of tartaric, oxalic, and citric acids—of *chlorids* of sodium, potassium, calcium, magnesium, barium and ammonium—of *sulphates* of soda, potassa, magnesia, iron, zinc and copper, and potash alum—of *nitrates* of potassa, ammonia and baryta—of chlorate of potassa, acetate of soda, oxalate of ammonia, bitartrate of potassa, bicyanid of mercury, yellow prussiate of potash, bichromate of potassa.

Among the results of interest was mentioned the fact, that *sulphuric acid* of the ordinary density absorbs at 60° under common pressure about 94 per cent. of its volume of CO_2, and Nordhausen acid 125, the absorption by pure water at the same temperature and pressure being 98.

This large absorptive power of sulphuric acid was dwelt on as specially important in its bearings on the various processes in which the gas, whose carbonic acid is to be measured, is desiccated by passing it through or over the acid. In the method of Fresenius, much used for estimating the carbonic acid of the carbonates, the authors found that from the absorption of the gas in passing through the sulphuric acid, an error of from 3 to 4 per cent. might readily arise. A similar objection was urged as applicable to the processes for determining the CO_2 of the atmosphere, of the air of mines, hospitals, &c., as employed by Boussingault and Lewy, LeBlanc, Orfila and others, in all of which the air was passed slowly over a large surface of sulphuric acid as a prliminary step to the analysis.

13. *On the Transporting Power of Currents;* by Prof. W. B. Rogers.—Prof. W. B. Rogers remarked that it was much to be regretted, that we were yet in possession of no *certain data* on the subject of the transporting power of currents. The usual statements affirming that at a certain rate of motion, a stream will car-

ry forward sand, at another gravel, &c., are evidently fallacious, as the important condition, of the smooth or rough configuration of the bottom, is not taken into the account. The problem is one of great difficulty, requiring an accurate determination of the velocity at the bottom and sides of the stream, when in ordinary cases the slow transporting action is in progress, and this velocity it is well known, differs from that of the axis of the stream and from the average speed of the whole mass, which is the datum usually sought by the engineer. The investigation of the subject systematically, was urged by Prof. Rogers as of fundamental interest in geological as well as hydrographical science, and he hoped that ere long the Association would institute a series of researches with that view.

14. *Fossils in the White Mountains.*—Prof. H. D. Rogers stated to the Association, that on a farther examination of his specimens from the White Mountain gap, he and his brother had satisfied themselves that the supposed fossils, which they had announced as discovered there by them, prove not to be fossils.*

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On some New Compounds of Phosphorus;* by A. Wurtz, (Compt. Rendus, Feb., 1847.)—When the chlorosulphuret of Serullas, $P Cl_3 S_2$, is digested in a water-bath with an excess of solution of soda, it gradually dissolves, and the liquid on cooling deposits crystals of a new salt which M. Wurtz designates as the *sulpho-phosphate of soda.* Its composition is such that it may be viewed as the ordinary tribasic phosphate of soda, in which two equivalents of oxygen are replaced by sulphur. The oxyphosphate being PO_5, $3NaO+24aq$, or according to Gerhardt's notation† $PO_4 (Na_3) +12aq$, the new salt is $PO_3 S_2$, $3NaO+24aq$, $=PO_3 S, (Na_3) 12aq$. Like the common phosphate it is very soluble, crystallizes in large tables which effloresce in dry air and have a strongly alkaline reaction.

Chlorine and nitric acid decompose the solutions of the sulpho-phosphates with the formation of phosphates, while sulphur separates; the sulpho-phosphoric acid has not been isolated. When set free by sulphuric acid, its solution is decomposed by a gentle heat into phosphoric acid and sulphuretted hydrogen, $PO_3 S (H_3)+H_2 O=PO_4 (H_3) +H_2 S$.

* See this Journal, ii ser., vol. i, p. 411.—While at the gap the past summer, very ambiguous appearances were observed in the slate near the Willey House, resembling oblong fossils. After some search they were found to be crystals of andalusite (or chiastolite) having the exterior much altered by decomposition. This mineral occurs in the gorges adjoining, in loose masses, and quite good specimens of chiastolite may be obtained. J. D. D.

† See this Journal, ii ser., vol. iv, p. 171.

M. Cloez (Compt. Rendus, March 8th, 1847) has described a sulpho-phosphovinic acid formed by the action of alcohol with the chloro-sulphuret of phosphorus of Serullas; it corresponds to the ordinary phosphovinic acid, and is represented by $PO_3 S_2, C_4 H_5 O, 2HO$ or in Gerhardt's notation, representing alcohol $C_2 H_6 O - H_2$ by E, $PO_3 S (H_2 E)$. By using alcoholic solutions of potash and soda, definite crystalline salts are obtained analogous to the phosphovinates; the potash salt is $PO_3 S (K_2 E)$. Wood-spirit yields in the same manner sulpho-phosphomethylates.

When the perchlorid of phosphorus is placed in an imperfectly closed flask containing a small tube of water, it is gradually changed into a liquid disengaging at the same time hydrochloric acid; the reaction is thus expressed; $PCl_5 + H_2 O = PCl_3 O + 2HCl$. The new product which M. Wurtz has described as the *chloroxyd of phosphorus* is a colorless liquid of a high refracting power, it has a specific gravity of 1·7 and boils at 110° C. It emits white vapors in the air, and by water is decomposed with the formation of phosphoric and hydrochloric acids. T. S. Hunt.

2. *Sulphoxyarsenic Acid.*—MM. Cloez and Bouquet have described a series of salts derived from a new tribasic acid, which is represented by $As O_3 S_2, 3HO$ or $As O_3 S (H_3)$. The sulphoxyarseniate of potash is formed by the action of sulphureted hydrogen upon a solution of arseniate of potash; its composition is $As O_3 S (K_3)$. These compounds differ from the sulpho-phosphates only in the substitution of arsenic for phosphorus. T. S. H.

3. *On some Combinations of Nitric and Hyponitric Acids;* by C. Gerhardt, (Ann. de Ch. et de Phys., xviii, p. 178.)—The author in this valuable paper has examined the composition of many of these salts and corrected some of the results of Prof. Graham on the constitution of the surbasic nitrates. The nitrates of magnesium, copper and others of that class cannot be obtained without water, while those of potassium, sodium, barium and silver are well known to be anhydrous. The nitrates of the first group have an acid reaction, while those of potash and silver are neutral; the former are decomposed by heat with the evolution of nitric acid and are changed into basic salts, while the latter part first with oxygen and are changed into nitrites. The two series are as well distinguished by these differences as the metaphosphates and triphosphates, and the former really belong to a tribasic type which is $NO_5, 3HO$, or $NO_4 H_3$. The proto- and per-nitrates of mercury pertain to this series. If we represent after Gerhardt's notation the peroxyd by $Hg_2 O$, and the protoxyd by $Hg_5 O$, we shall have in the one Hg, and in the other Hg_2, represented by $Hg\alpha$ replacing H.

The dimorphous proto-nitrate,	$= NO_4 (HHg\alpha_2)$
The crystallized per-nitrate,	$= NO_4 (HHg_2)$
Brook's salt of mercury,	$= NO_4 (Hg\alpha Hg_2)$

M. Gerhardt has examined two basic nitrates of lead; when the neutral salt is boiled with litharge or treated cautiously with ammonia, a salt separates in slender needles; it affords by analysis $2PbO, NO_5 HO$. The equivalent of water is retained at 212° F., but is driven off between 392° and 518°. This salt may also be arranged in the tribasic series, and its formula will be $NO_4 (Pb_2 H)$, corresponding to the tribasic

phosphate of soda PO_4 (Na_2 H). By a heat of 518° it is converted into a salt analogous to the pyrophosphates. An excess of ammonia in the cold produces an insoluble yellowish salt which yielded on analysis 4PbO, NO_5, 3HO.

[As phosphorus and arsenic are metaleptic with nitrogen, and sulphur with oxygen, we may arrange the tribasic nitrates, the triphosphates, the sulphophosphates, the arseniates, sulphoxyarseniates and triarsenio-persulphurets of Berzelius in the same group. Representing by *M* an equivalent of hydrogen or a metal we have—

Tribasic nitrates, ...	$NO_4 M_3$
Tribasic phosphates, ...	$PO_4 M_3$
Sulphophosphates, ...	$P(O_3 S)M_3$
Arseniates, ...	$As O_4 M_3$
Sulphoxyarseniates, ...	$As (O_3 S)M_3$
Triarsenio-persulphurets, ...	$As S_4 M_3$

The history of the arseniates is yet imperfect, and the monobasic and bibasic salts are unknown, but the arsenio-sulphurets which Berzelius has described as compounds of the persulphuret with one, two and three equivalents of sulphuret of potassium, correspond perfectly to the three classes of phosphates.] T. S. H.

4. *On the Products of the Decomposition of Gelatine by Chromic Acid;* by A. Schlieper, (Liebig's Ann., vol. lix, p. 1.)—Prof. Marchand has already made some examination of the products of this reaction;* but Mr. Schlieper has extended his enquiries, and while confirming some of Marchand's results, has corrected others and made some important discoveries. The best proportions of the ingredients are two of common glue, eight of bichromate of potash, fifteen of sulphuric acid, and fifty of water. If the proportion of sulphuric acid is increased, formic acid is the only product. The glue being dissolved in the water, is mixed with the acid and the pulverized bichromate, and carefully distilled until the residue grows thick. The distillate is acid and turbid with an odor of prussic acid; it is mixed with oxyd of mercury and redistilled; the first portions contain the volatile oily products and are collected apart. The distillation being continued, a strongly acid liquid passes over, which was neutralized with carbonate of soda. The soda salts decomposed by dilute sulphuric, afford crystalline *benzoic acid* and a mixture of *acetic* and *valerianic acids*. Besides these, a large quantity of prussic acid is formed which rests as a cyanid of mercury in the retort.

The oily products were purified by repeated rectification, first alone, and then with chlorid of calcium; they were finally separated by the difference in their boiling points. *Valeronitrile*, the less volatile oil, is colorless, limpid, slightly soluble in water, and readily in alcohol and ether. It has an acid aromatic taste, and an odor like the oil of bitter almonds or spirea; it is quite neutral, and boils at 257° F., it burns with a white flame. The composition of this body is $C_{10} H_9 N$; ammonia, nitric and hydrochloric acids, have no action upon it, but sulphuric acid decomposes it, evolving valerianic acid and forming sulphate of ammonia.

* See this Journal, ii ser., ii, 413.

Valeracetonitrile, the more volatile product, resembles the preceding, but has a more fragrant odor; its sp. gr. is ·79, and it boils between 154° and 156°. Its behavior with acids is similar to the last. Sulphuric acid evolves acetic and valerianic acids while sulphate of ammonia is formed. Analysis gives for its composition, $C_{26}H_{24}N_2O_6$.

[Valeronitrile is a valerianic amid, and contains the elements of valerianate of ammonia, *minus* four equivalents of water; $C_{10}H_{10}O_4$, $NH_3-4HO=C_{10}H_9N$. By the action of sulphuric acid, it assimilates the elements of water and regenerates ammonia and valerianic acid; it is quite analogous to the benzonitrile of Fehling. These compounds differ from ordinary amids by two equivalents of water, and are designated by M. Gerhardt, as *anhydrid amids*. The proper *valeramid* will be $C_{10}H_{11}NO_2$. Prussic acid is the anhydrid amid of formic acid, which is a homologue of the valerianic. And it will be interesting to observe, whether the characters of valeronitrile do not show that the homology extends to these amids.] T. S. H.

5. *On the Products of the Oxydation of Caseine*, (extract of a letter from Baron Liebig to Dr. A. Hoffmann, Philos. Mag., June, 1847.)—By the action of a mixture of peroxyd of manganese and sulphuric acid upon caseine, M. Gugelberger has obtained aldehyde, bitter almond oil, and a liquid identical in composition to metacetone. The aldehyde was analyzed as aldehydite of ammonia, of which a considerable quantity was obtained, and from the bitter almond oil, most beautiful benzoic acid was prepared by the action of chlorine. T. S. H.

6. *On the Decomposition of Cyanid of Ethyle;* by C. Frankland and Dr. H. Kolbe, (Chem. Gazette, June 1st, 1847.)—The so-called cyanid of ethyle of Liebig, was prepared after the process of Pelouze, by distilling together sulphovinate of potash and cyanid of potassium, and its purity was proved by analysis. It was added, drop by drop, to a boiling concentrated solution of potash, by which it was decomposed with a copious evolution of ammonia. The alkaline residue distilled with sulphuric acid yielded an acid liquid having all the characters of metacetonic acid. The analyses of its lead, silver, and barium salts, settled its nature beyond doubt. The cyanid of ethyle is also decomposed by dilute sulphuric acid with the same products.

[From these results it appears that this substance, which has no resemblance to an ether, is the anhydrid amid of metacetonic acid, and a homologue of valeronitrile. It takes up the elements of four equivalents of water to form metacetonic acid and ammonia. $C_6H_5N+4HO=C_6H_6O_4+NH_3$. According to M. Liebig, it is decomposed by oxyd of mercury, but he does not mention the results of its decomposition; if, as is probable, the oxyd takes up the cyanic elements and regenerates alcohol, it will be interesting to subject valeronitrile to its action, as we may expect to obtain the alcohol of the butyric series.] T. S. H.

7. *On the presence of Sugar of Milk in the Milk of the Carnivora;* by Dr. A. Bensch, (Chem. Gazette, June 1st, 1847, p. 212.)—Dr. Bensch has shown that, contrary to the results of Dumas, the milk of dogs fed entirely upon animal food, contains sugar of milk. The milk of a dog which had been fed entirely upon the flesh of an old horse for five days, afforded perfect crystals of milk sugar, and the same result

was obtained after an exclusive flesh diet of twelve and twenty-seven days. The milk had an acid reaction at the moment it was taken from the teat, and was readily coagulated by heat. The author considers that the acidity of the milk was due to the presence of an acid phosphate of lime, which in the ordinary process for examination changes the sugar of milk into glucose during the evaporation. In his experiments the whey was evaporated with carbonate of magnesia; when concentrated alone, no crystals could be obtained, but the liquid gave evidence of the presence of glucose by reducing the salts of copper in the presence of potash. T. S. H.

8. *Silicates in the Blood of Fowls;* (Chem. Gazette, Feb. 15, 1847.) —M. Henneyberg has found that the blood of fowls contains silicate of soda or potash, which explains the fact previously observed by M. Gorup-Besanez, that their feathers contain a large amount of silica. T. S. H.

9. *On the existence of Copper, Arsenic, Antimony, and Tin in Mineral Waters;* (Chem. Gazette, Feb., 1847, p. 54, and Ann. der Chem. und Pharm., t. lxi, p. 219.)—M. Tripier sometime since detected arsenic in the mineral waters of Meskontine in Algiers, and M. Walchner having found that small quantities of copper and arsenic are generally present in various ores of iron, as the hydrated oxyd, sparry iron ore, and the argillaceous and bog ores which may be regarded as deposits from ferruginous waters, was led to search for them in the deposits from chalybeate springs. These were dissolved in hydrochloric acid and treated with sulphureted hydrogen; the precipitate was then examined for these metals in the ordinary manner. In this way he examined the sediments of the chalybeate waters of Griesbach, Rippoldsau, Tienach, Rothenfels, and Cannstadt, as also the hot springs of Wiesbaden and the effervescent waters of Ems, Pyrmont, Lamscheid, and Brohl; arsenic and copper were found in all of these, and antimony in that of Wiesbaden. M. Figuer has confirmed these results with the water of Wiesbaden; 100 litres of it contain about 0·045 grammes of arsenious acid. The usual dose of the *Liquor arsenicalis, Boudin*, contains 0·005 grammes of arsenious acid, as much as is found in the 11 litres of the Wiesbaden water. It probably exists as an arsenite of soda, but when the iron in the water becomes per-oxydized it combines with the acid and is deposited as an arsenite of iron.

M. Buchner has confirmed these results by examinations of the mineral waters of Bavaria; in addition to copper and arsenic the ochreous deposits from the ferruginous springs of Bruckenau and Kissingen contain tin.

M. Will has since detected tin in the chalybeate water of Rippoldsau, with antimony, arsenic, copper, and lead. 10,000,000 parts of the water of the three springs of St. Joseph, St. Wencelas, and St. Leopold, contain,—

	1	2	3
Arsenious acid, . .	6·00	4·00	9·00
Protoxyd of tin, . .	0·25	0·17	0·38
Oxyd of antimony, .	0·16	0·10	0·24
Oxyd of lead, . .	0·25	0·69	1·56
Oxyd of copper, . .	1·00	0·16	0·37

T. S. H.

10. *On the transformation of Tannic into Gallic acid;* by Mr. CHAS. WETHERELL, (Ann. de Pharm. et de Chimie, Aug., 1847, p. 107.) —It is well known that nearly all reagents convert tannic into gallic acid; acids, alkalies, ferments, and decomposing animal matters, cause the separation of gallic acid without the evolution of gas and quite independent of the presence of air. The experiments of the author were made to ascertain whether, in the transformation by dilute sulphuric acid, any other substance was formed. The proportions used were one measure of acid, sp. gr. 1·840, and four of water; to 500 cubic centimetres of this, 50 grammes of pure tannic acid, prepared after the process of Pelouze, were added, and the mixture boiled until it crystallized on cooling; the liquid then set aside deposits an abundance of very white gallic acid.

The liquid neutralized by carbonate of baryta, evaporated, and treated with ether, gave 12 per cent. of residue, principally gallate of baryta with one or two per cent. of a black matter "apparently due to some impurity of the tannin." In varying the process in different ways the same result was obtained, besides the black substance nothing but gallic acid could be detected. The maximum amount of gallic acid that could be obtained was 87·4 for 100 of tannin.

From these experiments the author concludes that the transformation is a result of hydration, and that tannin is isomeric with gallic acid dried at 100° C. The composition of the two is thus compared :—

Gallic acid by Pelouze.		Calculated.		Tannin by Wetherell.		Calculated.	
C	49·56	C_7	49·41	C	50·63	C_{18}	50·93
H	3·70	H_3	3·53	H	3·64	H_8	3·79
O	46·74	O_5	47·06	O	45·73	O_{12}	45·28

"These numbers," observes Mr. Wetherell, "correspond very nearly, and when it is considered that we are never sure of the purity of the tannic acid, which does not crystallize, that little differences in the composition of the two may be due to impurities, and also that the tannic acid has a tendency to combine with two equivalents of a base, we may conclude that it is isomeric with gallic acid dried at 100° C.; and that representing this by $C_7\ H_3\ O_5$, the tannic acid may perhaps be $C_{14}\ H_8\ O_{10}$, and finally that when we act upon tannic acid by different reagents, the crystallized gallic acid is formed by the absorption of an equivalent of water."

[As the true formula of gallic acid is represented by $C_7\ H_3\ O_5$ or a multiple of it, and the water that it loses at 212° is only that of crystallization, it is hardly proper to speak of the change as due to hydration; it is really, upon his view, a simple division or diamorphosis of the tannin precisely analogous to that by which an equivalent of cyanuric is transformed into three of cyanic acid.

The composition of tannin seems pretty well settled from the examination of its compounds, and we can hardly admit without farther experiments, that the impurities in the acid analyzed are so great as to warrant the change proposed in its formula. It will be seen that the proposed formula requires 1·22 parts less of carbon and 1·33 more of oxygen than were obtained by Mr. Wetherell, whose results agree well with those of other chemists. Moreover it is difficult to account for the

fact that only 87·4 parts of gallic acid could be obtained for 100 of tannin, leaving 12·6 parts unaccounted for, except by the presence of one or two parts of an unexamined black matter.

Liebig some years since, pointed out the fact that tannic acid, by taking up the elements of water, might yield gallic acid and glucose or acetic acid, $C_{18}\ H_8\ O_{12}+2HO=2C_7\ H_3\ O_5+C_4\ H_4\ O_4$. The formula of tannin appears from its compounds with baryta to be at least twice the above. Berzelius has described a salt which is $C_{36}H_{14}Ba_2O_{24}$, besides an acid one not analyzed; if, as is not improbable, it is $C_{54}\ H_{24}\ O_{36}$, it may combine with six equivalents of water and form six of gallic acid and one of glucose. As yet however no one has detected glucose or any product of its decomposition as a result of the process, unless the blackish substance formed by the action of both acids and alkalies be reckoned such; by the combined action of the air and dilute acids, Malaguti has shown that glucose is oxydized and yields formic acid.

A fact which militates strongly against the view of the isomerism of tannin and gallic acid, is the observation of Pelouze, that a solution of tannic acid confined over oxygen, was converted into gallic acid, while the oxygen was replaced by an equal volume of carbonic acid gas. Robiquet indeed denies that the presence of oxygen is essential to the change; but the reaction without it will probably be like that produced by the action of the various ferments. The subject is interesting and seems still open for investigation.] T. S. H.

11. *On two new Alkaloids obtained from Aldehyde;* by Wöhler and Liebig, (Compt. Rendus des Trav. de Chemie for May, from Annal. der Chem. und Pharm., t. lxi, p. 1.)—When a solution of pure aldehydate of ammonia in twelve or sixteen parts of water is mixed with a few drops of ammonia and a gentle current of sulphureted hydrogen is passed through the liquid, it becomes milky after about half an hour and deposits a great quantity of large crystals resembling camphor in appearance. After four or five hours when the deposition is finished, the product is washed in cold water, and dissolved in a mixture of alcohol and ether. By the spontaneous evaporation of the solvent, the new substance is obtained in large rhombic tables of the form of selenite and having a high refractive power.

This constitutes a new alkaloid to which the authors have given the name of *thialdine*. It is scarcely soluble in water, but dissolves readily in alcohol and ether; it fuses at 107° F. and is volatile at ordinary temperatures. It may be distilled with the vapor of water, but alone is decomposed by heat; its taste is at first aromatic but afterwards disagreeable; at 64° F., its specific weight is 1·191.

With a solution of acetate of lead it gives after some time a white precipitate which gradually becomes red and at last black; with nitrate of silver, the reaction is similar; when heated with a solution of this salt, sulphuret of silver separates and an inflammable vapor escapes having the characters of aldehyde. Distilled with hydrate of lime, it evolves a substance having the odor of quinoleine.

The composition of thialdine is $C_{12}\ H_{13}\ NS_4$; three equivalents of aldehyde, one of ammonia and four of sulphureted hydrogen, contain the elements of one equivalent of thialdine and six of water, $3C_4\ H_4\ O_2 + NH_3 + 4HS = C_{12}\ H_{13}\ NS_4 + 6HO$.

It is without action upon vegetable colors, but combines with acids forming salts which crystallize beautifully; the *hydrochlorate of thialdine* is formed by dissolving the alkaloid in the dilute acid; it crystallizes in prisms, is readily soluble in water but insoluble in ether; it contains $C_{12}H_{13}NS_4HCl$. The *nitrate* is obtained in delicate needles when an ethereal solution of thialdine is agitated with nitric acid; its formula is $C_{12}H_{13}NS_4, NHO_6$.

By the action of seleniureted hydrogen upon a solution of aldehydate of ammonia, the authors obtained small crystals of an alkaloid which contained selenium; they regard it as analogous to the last and have named it *selenaldine*, but from the facility with which it is decomposed by the air, they have been unable to make a proper examination of it.

[This sulphureted alkaloid evidently corresponds to a normal species $C_{12}H_{13}NO_4$, which will be an amidized derivative of elaldehyde, in which the residue NH replaces O_2. If we consider the changes as consecutive, the first step will be the union of three equivalents of aldehyde to form one of its polymere elaldehyde, which reacts with one equivalent of ammonia, forming with the elimination of the elements of two equivalents of water, the body $C_{12}H_{13}NO_4$; this by the action of sulphureted hydrogen exchanges its oxygen for sulphur.

The normal species will be a homologue of glycocoll, and it appears to me very probable that it is no other than *leucine*. This substance which is formed by the action of sulphuric acid or potash upon gelatine and fibrine, combines with acids like an alkaloid, and the nitroleucates are similar in constitution to the nitrosaccharates, which Prof. Horsford has shown to be direct combinations of glycocoll with nitrates. Mulder from his analysis of leucine has deduced the formula $C_{12}H_{12}NO_4$; this is anomalous as presenting an even number of equivalents of hydrogen with one of nitrogen. But if the formula is $C_{12}H_{13}NO_4$, the anomaly disappears, and in the analysis of a body of so high an equivalent, a very small error in the per-centage of the hydrogen is sufficient to make the difference.]* T. S. H.

12. *On Perchromic Acid;* by M. Barreswill, (Ann. de Chem. et de Phys.)—Concentrated solutions of chromic acid and peroxyd of hydrogen, when mixed, produce violent effervescence from the escape of pure oxygen; on the contrary, when the solutions are very dilute the mixture becomes intensely blue, but the color is very unstable and evidently belongs to a peroxyd of chromium. Every attempt to isolate this substance failed.

After the escape of oxygen the chromium is no longer found as acid but as oxyd. Upon this property was based a process in which the oxygen was measured, and the composition of the blue substance determined. This was found to be Cr_2O_7 or *perchromic* acid.

The only approach to the separation of this acid, is by agitation with ether which becomes colored, the water remaining colorless. The evaporation of the ether however leaves chromic acid. It is somewhat

* The formula $C_{12}H_{12}NO_4$ requires H=9·23 and in $C_{12}H_{13}NO_4$, H=9·92; not having access to Mulder's analysis, I am unable to compare these numbers with those obtained by him.

remarkable that the only salts of perchromic acid which could be formed were those with vegetable bases, quinine and strychnine, giving dirty violet precipitates of very slight stability.

Vanadic acid seems to be capable of similar transformation.

[It is not unlikely that perchromic acid may be formed in other ways. Some time before the researches of Mr. Barreswill, the writer of this attempted to obtain this body by the fusion of chlorate of potassa with the bichromate; at a certain stage of the process a greenish blue color uniformly appeared, but quickly vanished. At first it was thought that the presence of organic matter had produced a partial reduction, but this was found not to be the case.] G. C. SCHAEFFER.

13. *Bromid of Carbon an Impurity of Commercial Bromine;* by M. POSELGER, (Poggendorff's Annalen.)—The distillation of commercial bromine gave a boiling point rising from 122° to 248°, the portion remaining in the retort became lighter and finally a colorless liquid remained. The last portions freed from bromine by water and potash gave an oily aromatic colorless liquid. This substance is a bromid of carbon, CBr. Its properties are as follows. Sp. gr. 2·436; odor ethereal and aromatic; taste sweet; boiling point 248°. Nitric and sulphuric acids produce scarcely any decomposition. Soluble in water sparingly, in alcohol and ether in every proportion.

This impurity to the extent of 6 to 8 per cent. is probably formed by the ether used in the preparation of bromine. Bromine distilled with ether gave little or none of it, unless chlorine had previously been passed through the mixture. A mixture of alcohol or pure alcohol gave a larger quantity, containing however much chlorine. G. C. S.

14. *On the Dehydration of Monohydrated Sulphuric Acid;* by M. BARRESWILL, (Comptes Rendus, July, 1847.)—This process had never been directly performed until M. Barreswill derived the following simple method. Anhydrous phosphoric acid is mixed with strong commercial sulphuric acid and the mixture is gently heated. Distillation as with the Nordhausen acid, disengages anhydrous sulphuric acid, and the vitreous hydrate of phosphoric acid remains. It is remarkable that the mixture does not affect organic matter, as paper and cotton, which are instantly destroyed by the Nordhausen acid.

This process, although theoretically interesting, can never be adopted as an economical mode of preparing anhydrous sulphuric acid.

G. C. S.

15. *Solubility of Chlorid of Sodium in Alcohol;* by R. WAGNER, (Jour. f. Prakt. Chem., May, 1847.)

At 57° F.	alcohol of	0·876	dissolves	0·661	pr. ct.	of chlorid	of sodium.
59	" "	"	"	0·700	"	"	"
101	" "	"	"	0·736	"	"	"
161	" "	"	"	1·033	"	"	"
59	" "	0·815	"	0·174	"	"	"
171	" "	"	"	0·171	"	"	"

G. C. S.

16. *On Silica;* by M. DOVERT, (Comptes Rendus, July, 1847.)—1. Excess of acid, particularly the hydrochloric, if added drop by drop to the alkaline silicates, throws down nearly all the silica; the same quantity added at once, does not precipitate the smallest portion.

2. Silica once precipitated in any way, does not redissolve in acid.

3. Weak acids decompose alkaline silicates at common temperatures, the silica appearing as jelly or in gelatinous flocculi.

4. Finely divided hydrous or anhydrous silica decomposes the solutions of alkaline carbonates and dissolves in them, at a boiling heat.

5. Silica at common temperatures from an alkaline silicate or fluorid of silicium, is a definite hydrate HO Si O; heated to 212°, it becomes $HO\,2SiO_3$.

6. Metallic solutions precipitate from an alkaline silicate a mixture of hydrate of silica and a metallic silicate; the latter alone dissolves in the mineral acid.

7. A clear and very strong solution of silica in hydrochloric acid is obtained by dissolving silicate of copper in the acid and precipitating the copper by sulphuretted hydrogen.

8. The last named solution evaporated under the air-pump gives the hydrate $HO\,SiO_3$ in perfect crystals, which are small transparent needles in stars or tufts. G. C. S.

17. *On the Inorganic Substances in the different parts of Plants;* by Dr. C. RAMMELSBERG, (Poggendorff's Annalen.)—The examination of peas and rape showed a remarkable difference between the arrangement of the inorganic constituents of the seeds and the straw. In these plants the seeds contained potash without a trace of soda; the straw contained both alkalies, but most of the soda. Lime and magnesia are present in all parts of both plants—the former predominates in the straw, the latter in the seed. Phosphoric acid, which forms nearly half of the ash of the seed, is found only in small quantity in the straw. The chlorids and sulphates, on the contrary, exist in abundance in the straw and in small quantity in the seeds; the carbonic acid of the ash, derived from organic acids, &c., varies in a similar manner.

The analyses of several other seeds, &c., quoted by Rammelsberg, seem to agree tolerably well with the supposition that potash predominates in the seed—soda in the straw or wood; this is certainly not a universal rule. The large quantity of phosphoric acid in seeds has been noticed by other authors. G. C. S.

18. *On the Artificial Production of Minerals and Precious Stones;* by M. EBELMAN, (Comptes Rendus, Aug., 1847.)—The process adopted by the author is in reality a crystallization of the compound from a fused solution of their constituents in boracic acid, the acid being evaporated by heat.

Alumina and magnesia, in proportions to form spinel, were mixed with fused boracic acid and one per cent. bichromate of potash. Exposed on platina foil to the highest temperature of the porcelain furnace of Sèvres, a product was obtained; the surface and interior cavities of which were covered with crystalline facets having the form of the regular octahedron; rose red, transparent and readily scratching quartz. They were completely infusible by the blowpipe—and there can be no doubt of their identity with spinel.

A substitution of protoxyd of manganese for the magnesia produced large laminæ, having the form of equilateral triangles or regular hexagons. These were apparently manganesian spinel, which has never yet been found in the mineral kingdom. Oxyd of cobalt substituted for magnesia, gave blue-black regular octahedrons.

Alumina and glucina in proportions to form chrysoberyl, gave a mass with a crystalline surface of great splendor, and scratching quartz and even topaz. The hardness was therefore that of natural chrysoberyl.

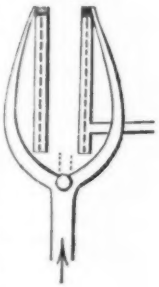
Silicates infusible in furnaces, can be formed by the same process. The constituents of emerald gave a substance which readily scratched quartz, and had the form of the regular hexagon.

The author concludes that many mineral species may be formed at a lower temperature than that required for their fusion. G. C. S.

19. *Improved exciting fluid for Grove's Battery;* by C. DEWEY, (in a letter to Professor Silliman, dated Rochester, N. Y., Nov. 20, 1847.) —Since the publication on this subject in the Journal for May last, vol. iv, p. 427, the sulphate of soda continues to be used with most gratifying success in the batteries of the magnetic telegraph. The dilute sulphuric acid must be kept *saturated* with the sulphate of soda to ensure entire success. The mercury does not in this condition appear to be attacked on the amalgamated zinc. The high solvent power of this solution may, as you have suggested, be one advantage. The chief result however is in preventing the nitric acid from uniting with the mercury. As nitrate of soda is found in the solution, it must be that the sulphate of soda is decomposed and nitrate of soda formed by the action of the voltaic power, when this will not take place in ordinary cases or without this electrolysis. The sulphuric acid of the glauber's salt is set at liberty to act on the zinc, and thus a permanent action maintained, provided the waste of the nitric acid in the porous cup be occasionally and duly supplied by new portions of the acid. I have seen only a teaspoonful or two of the acid used at a time to supply this waste. The action of the battery appears more uniform by the use of the glauber's salt. No successful attempt to prevent the destruction of the mercury in this battery had been made until this use of the glauber's salt or of alkaline sulphates.

20. *Spirit Lamp for securing extreme heats with little delay;* by Prof. EBEN N. HORSFORD.—For glass-blowing, the oil lamp with the aid of a bellows has served for a great length of time, and in the hands of a skillful blower, leaves for some purposes little to desire. It is however dirty, requires constant picking up, is cumbrous, and cannot well be transported from place to place. It demands, beside, no little experience to be able to keep up a high, strong heat, and for a variety of reasons cannot well be employed in the fusion of silicates.

Fig. 1.

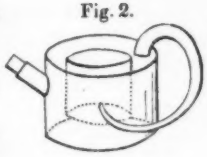


Plattner's apparatus, fig. 1, which is essentially a Berzelius lamp with a reservoir of air, worked by bellows and discharged on the margin of the flame, through a series of jet-tubes gives a strong heat. It is clear, but is liable to the objection of not being moveable.

The lamp of Dr. Charles T. Jackson is upon the same principle, having in place of the separate jets a continuous annular jet, in connection with a reservoir of oxygen, or a strong blast of atmospheric air, from a bellows driven by the foot.

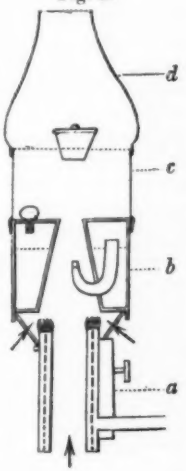
The simple cup eolipile, fig. 2, gives perhaps a stronger heat than can be derived from a Berzelius lamp with a chimney, but will not serve for fusing silicates with soda, or for drawing out large glass tubes.

Fig. 2.



An apparatus, fig. 3., which unites all the desired excellences and which is but a slight modification of one previously in use in Germany, was introduced by the writer into the Giessen School last year.

Fig. 3.



It is clean, may be moved with as much facility as the Berzelius lamp, gives a most intense heat for purposes of fusion, and may be employed with the greatest convenience in all kinds of glass blowing occurring in a laboratory.

Fig. 3 exhibits a cross section of this apparature. It rests upon a simple, inverted tripod secured above by a flange, and below in a ring with a clamp fastening it to the wick cylinder.

The following references will give all needed explanation:—*a*, Berzelius lamp; *b*, the spirit-lamp of strong copper. It should be filled with alcohol to the dotted line. The jet is tipped with platinum and unscrews. The supply-opening in the lamp is closed by a screw; *c*, cylinder for the support of a triangle and crucible; *d*, upper chimney at the top of which glass may be drawn.

Cambridge, August 4, 1847.

II. Mineralogy and Geology.

1. *Report on Crystalline Slags produced in the Smelting and Manufacture of Iron;* by John Percy, M.D., and William Hallows Miller, M.A., Professor of Mineralogy, Cambridge, (Rep. Brit. Assoc., for 1846.)—The following are the results of the analyses of Dr. Percy, with a statement of the crystalline form and other characters as given in the memoir.

Slag crystals, allied to Idocrase.—The first series examined contained six specimens from hot-blast furnaces in the vicinity of Dudley, near Tipton; and one from a hot-blast furnace named La Providence, at Marchienne, Charleroi, Belgium.

The crystals were square prisms or their secondaries, and were similar in form. H. =5·5—6. The analyses all agree quite closely; we cite four of them.

	No. 1.	No. 2	No. 3.	No. 4.	Oxygen in No. 4.
Silica,	38·05	38·76	37·63	37·91	19·60
Alumina,	14·11	14·48	12·78	13·01	6.08
Lime,	35·70	35·68	33·46	31·43	
Magnesia,	7·61	6·84	6·64	7·24	12·27
Protoxyd of manganese,	0·40	0·23	2·64	2·79	
Protoxyd of iron,	1·27	1·18	3·91	0·93	
Potassa,	1·85	1·11	1·92	2·60	0·44
Sulphuret of calcium,	0·82	0·98	0·68	3·65	
Error of loss,	0·19	0·74	0·34	0·44	
	100·00	100·00	100·00	100·00	

1.	Specific gravity,	2·9052	at	19°·2	C.
2.	"	2·9152	"	19°·2	C.
3.	"	2·9242	"	19°·1	C.
4.	"	2·9187	"	18°·2	C.

"From the analyses, the following formula is deduced :—

$$Al^2O^3, SiO^3+2\,(3(Ca, Mg, Mn, Fe)\,O, SiO^3).$$

The formula differs from that of idocrase, in containing two equivalents of the silicate of lime series instead of one. Ivanov however has described a mineral from Slatoust, identical in composition with the preceding slags;* but Professor H. Rosé informs us that the analysis of Ivanov has been clearly proved erroneous. Berthier has given the results of several analyses of slags from blast furnaces of nearly the same composition, but has incorrectly deduced the formula '(Ca, Mg, M, f) S+AS,' which is that of idocrase. He has also omitted in his analysis of a slag from Dudley, protoxyd of manganese, potassa and sulphur, which were found in all the preceding analyses of slags from the same locality."

Crystalline slag, allied to Gehlenite.—Slag (No. 7) was obtained from one of Mr. Dawes's hot-blast furnaces at Oldbury.

The crystals were thin square plates, the lateral faces of which were perpendicular to each other, and to the terminal faces. They appeared to belong to the pyramidal system. They are white, and when very thin transparent. Hardness =5·7.

The composition (analysis No. 7, below,) approximates very nearly to that of Gehlenite.

"The oxygen of the silica is to the oxygen in either the alumina or lime bases in the proportion of 4 to 3. This leads to the formula,

$$3(3CaO, Si\,O^3)+3Al^2\,O^3, Si\,O^3,$$

or as represented by Berzelius's method of notation,

$$3\dot{C}a^3\,\ddot{S}i+\ddot{A}l^3\,\ddot{S}i,$$

which also appears to represent the constitution of Gehlenite more nearly than $2\dot{C}a^3\,\ddot{S}i+\ddot{A}l^2\,\ddot{S}i$, which is usually assigned to it."†

"Admitting this slag to be really Gehlenite, the circumstance of its production at a high temperature in an iron furnace, may possibly be made available by the geologist in explaining the formation of the rocks in which the natural mineral occurs in Fassathal in the Tyrol."

Crystalline slag, allied to Humboldtilite.—No. 8 was also from Mr. Dawes. It was obtained during the process of remelting cast iron with lime in a small cupola.

It is a mass of pearl-gray slag containing imbedded long yellow crystals, which appear to be square prisms with the angles truncated; cleavable perpendicular to the axis of the prism. In part of the specimen the crystals are very fine and radiated.

"Without attempting to extort from the analytical results a precise atomic expression, we may state that probably the formula of Hum-

* Rammelsberg, Part ii, p. 258, and first supplement, p. 151.
† Rammelsberg, Handwörterbuch, Theil i, p. 250; second supplement, p. 53.

boldtilite, as deduced from the analysis of von Kobell,* nearly represents the constitution of this slag.† The formula in question is

$$3\dot{R}^2\,\ddot{S}i + \ddot{\mathbf{R}}\,\ddot{S}i.$$

"Damour assigns a different formula for Humboldtilite, which he believes to be identical with mellilite; and this formula is precisely that which we have given for the first series of blast-furnace slags.‡

	No. 7.		No. 8.	
	Analysis.	Oxygen.	Analysis.	Oxygen.
Silica,	28·32	14·71	45·59	23·68
Alumina,	24·24	11·33	11·88	5·18
Lime,	40·12	12·42	38·20	11·18
Magnesia,	2·79			
Protoxyd of manganese,	0·07		0·91	
Protoxyd of iron,	0·27		1·11	
Potassa with a trace of soda,	0·64	0·11		
Sulphate of lime,	0·26			
Sulphuret of calcium,	3·38		1·76	

"Berzelius remarks on Damour's results, that 'in designating by *r* the bases with 1 atom of oxygen, and by R the bases with 3 atoms of oxygen, the formula $2rS+RS$ will be obtained, which expresses a somewhat rare kind of composition.'"

Crystalline slags, allied to Pyroxene.—Nos. 9 and 10 were communicated by M. Krantz, the well-known mineralogist of Berlin. They were labelled, Olsberger Furnaces, on the Rhine.

No. 9 contains a drusy cavity with projecting crystals, which are not sufficiently bright for measurement with the reflective goniometer. They appear to belong to the oblique prismatic system. They have a single end-face which is not at right angles to the axis of the prism. Hardness = 5. No. 10 is a mass exhibiting a radiated crystalline structure, the individuals of which are too small for measurement. Hardness = 5·7.

To one side of each of these specimens are attached minute scales of graphite.

The analyses gave the following results:—

	No. 9.	No. 10.
Silica,	53·37	53·76
Alumina,	5·12	4·76
Lime,	30·71	29·48
Magnesia,	9·50	9·82
Protoxyd of manganese,	1·41	1·30
Protoxyd of iron,	0·95	1·48
	101·06	100·60

"With the exception of a few small crystals in a drusy cavity in No. 9, the crystallization of the two preceding slags is confused, so that we could scarcely hope to deduce from their composition a satisfactory formula. The oxygen of the acid being nearly double that of the

* Rammelsberg, 2d Part, p. 308.
† See, for this analysis, Dana's Mineralogy, p. 359.
‡ Ibid, p. 526, and Alger's Mineralogy, p. 633.

bases, the slag is formed of bisilicates, and evidently approximates very nearly in composition to some varieties of augite (pyroxene) containing alumina."

Crystalline slags, undetermined.—No. 11 was brought by Mr. Blackwell from the hot-blast furnaces called L'Espérance, at Seraing, near Liège, in Belgium.

This slag is brown, porous, and confusedly crystalline.

	Analysis.		Oxygen.
Silica,	55·77		28·97
Alumina,	13·90		6·49
Lime,	22·22		
Magnesia,	2·10		
Protoxyd of manganese,	2·52		8·09
Protoxyd of iron,	2·12		
Potassa,	1·78		0·30
	100·41		

"As the crystallization was very confused, and as the analytical results do not point satisfactorily to a formula, we do not attempt to deduce any rational expression of the composition of this slag."

No. 12 is a specimen of "refinery cinder" produced in the Bromford Iron Works, near Birmingham, and was communicated by one of the proprietors, our friend, Mr. John Dawes. The process of refining, which is not now extensively practised in Staffordshire, consists in exposing the surface of melted cast iron to the action of a blast. The products are refined or white iron, and "refinery cinder" or slag.

	Analysis.		Oxygen.
Silica,	22·76		11·83
Protoxyd of iron,	61·28		13·95
Protoxyd of manganese,	3·58		0·70
Alumina,	7·30		3·41
Lime,	3·41		0·97
Magnesia,	0·76		0·29
Sulphur,	0·46		
Error of loss,	0·45		
	100·00		

"From the identity in crystalline form of this slag with the one succeeding, we are inclined to regard it as a mixture of silicate of protoxyd of iron with a considerable amount of impurity, represented especially by the alumina. This view would also appear to receive confirmation from an inspection of the slag itself. We need scarcely refer to the numerous instances of well-formed crystals containing much foreign matter, so that there seems to be nothing improbable in this view respecting the composition of the crystals of this slag, which are certainly not perfectly formed."

Crystalline slags of Silicate of Iron.—No. 13 is a beautifully crystallized specimen presented by Mr. Dawes. It was found in the flue of a puddling furnace, where it had probably been exposed to a high temperature for a considerable time.

The surface of this slag is covered with bright black crystals, exhibiting occasionally an iridescent tarnish. The crystals belong to the

prismatic system, and resemble those of chrysolite. The crystals have the faces of two rhombic prisms, one of 130° 36′, and the other of 81° 36′.

Hardness = 6. Specific gravity at 18°·6 C. = 4·0805.

"Crystals similar to these in form, composition and mode of occurrence, were described by Mitscherlich in the Annales de Chimie, t. xxiv. Measurements of crystals of the same form, and a comparison of their angles with those of olivine, were given by one of the authors (W. H. M.) of the report in the third volume of the Transactions of the American Philosophical Society.

"Estimating the whole of the iron as protoxyd, the composition would be nearly that of $\dot{Fe}^3 \ddot{Si}$, the formula assigned by Thomson to the mineral from Ireland, named 'Anhydrous silicate of iron.' Now, this slag had evidently been in a position favorable to the absorption of oxygen, namely, the flue of a puddling furnace; and we shall probably be justified in supposing that, after crystallization as silicate of protoxyd of iron, oxygen may have been absorbed, and that the crystal may consequently be regarded to a certain extent pseudomorphous. In the case of the following slag, which is similar to the one in question, it was found by experiment that the powder of the slag readily absorbed oxygen by calcination in the air. If this view be admitted, the slag will in constitution as well as form resemble olivine, the magnesia of the latter being replaced by protoxyd of iron."

Composition.	No. 13.		No. 14.	
	Analysis.	Oxygen.	Analysis.	Oxygen.
Silica,	29·69	15·37	23·86	12·41
Protoxyd of iron,	48·43	11·02	39·83	9·07
Sesquioxyd of iron,	17·11	5·24	23·75	7·28
Protoxyd of manganese,*	1·13	0·25	6·17	1·38
Alumina,	1·28	0·59	0·91	0·42
Lime,	0·47	0·13	0·28	0·08
Magnesia,	0·35	0·13	0·24	0·09
Phosphoric acid,	1·34	0·75	6·42	3·60
Sulphuret of iron,	1·61		0·62	
	10·132		102·08	

No. 14 is a slag "found by Mr. Twamley at the Bloomfield iron-works, Tipton, in a heap of calcined puddling furnace slag, technically called 'tap cinder.' The proprietors of these works have secured by patent the application of calcined tap cinder for the beds of puddling furnaces. It is stated that, by the process of calcination, which is conducted in large kilns similar to brick-kilns during a fortnight or three weeks, the slag is rendered much less fusible, and is therefore well adapted to the purpose to which it is applied. The analysis will probably explain this fact. The heat of the kilns appears, from an examination which one of us has made (J. P.), to be sufficient to soften and agglutinate the pieces of slag together, but not to effect perfect fusion.

"This slag is a mass of large iron-gray crystals, the faces of which though even are much too dull to be measured with the reflecting go-

* Probably a portion existed as a superior oxyd.

niometer. The general resemblance of their forms, however, to those of No. 12 is so close, as to leave no doubt of their crystalline identity.

"At 18·2° C., specific gravity = 4·1885.

"It attracts the magnetic needle strongly."

"We regard slag No. 14 as similar in constitution to the preceding, the alumina, some of the sesquioxyd of iron, and the phosphoric acid being present as impurity. The presence of so large a quantity of sesquioxyd of iron in this slag, is probably to be explained by its long exposure in the kiln, during which it was in a condition favorable to the absorption of oxygen. The powder of the slag, when heated to redness in a platinum crucible, changes color, acquiring a brown tint, and increases in weight. The quantity of phosphoric acid is also remarkable, and is well deserving the attention of those engaged in the smelting of iron. Berthier has given the analysis of a refinery slag from Dudley (Traité des Essais, t. 2, p. 289) containing 7·2 per cent. of phosphoric acid. It is found that when puddling furnace slag (tap cinder) is worked with the ordinary ores of iron, such as argillaceous ore and hematite, the iron is liable to be 'cold short,' or possess that property which is known to be dependent upon the presence of phosphuret of iron. Now it is evident that in smelting tap cinder, which will probably always be found to contain a sensible amount of phosphoric acid, the manufacturer will be introducing into the furnace the very element, in a concentrated form, which it is one object of the puddling furnace to remove, namely, phosphorus. An immense quantity of iron slag, far richer than many iron ores, is annually thrown away, and it may be that the presence of phosphorus in sensible quantity is one of the causes which prevents the resmelting of this slag with advantage. This fact has not yet sufficiently attracted the attention of those engaged in the manufacture of iron. The discovery of a method of extracting economically good iron from these rich slags, would be of great advantage to the country, and could not fail amply to reward its author."

No. 15 is inferred from the measurements of Prof. Miller to be identical with No. 13.

2. *Mineral Localities in New York;* by F. B. H.—The following mineral localities are not mentioned in the Final Geological Reports of New York.

Carbonate of Strontian occurs in the town of Theresa, Jefferson Co., in considerable quantities. It much resembles specimens from Strontian Island in Lake Erie.

Yellow Ochre is found in Rutland, Jefferson Co., near the banks of Black River. It has been used to a limited extent.

Chalcedony occurs in nodular masses of considerable size in the rock at Natural bridge, Jefferson Co. Good specimens may be procured.

Zircon has been detected by Mr. Wilder of Lowville, occurring with scapolite, sphene, pyroxene, &c., on the farm of Mr. Cleveland in Diana, Lewis Co. It is in small but very brilliant prismatic crystals, possessing the usual crystalline forms. It is rare; but a very few crystals having been found.

Magnetic Oxyd of Iron has been recently found in beds in the gneiss rock of Greig, Lewis Co. The mine has been explored to some extent and sufficient indications of abundance exist.

Sulphuret of iron in grains occurs disseminated uniformly through the ore and in sufficient quantity to materially impair its value.

As most of the ore is obedient to the magnet, it may be purified from the pyrites by the magnetic separating machine. The bed in which it occurs is parallel with the strata of the gneiss which here have an east and west course and dip at a high inclination to the south. The constituent minerals of the gneiss occur, frequently separate, forming parallel bands in the rock. This is the only known locality of magnetic iron ore on the western side of the great northern forest of New York.

III. Botany and Zoology.

1. *Dried Plants from Santa Fe, New Mexico.*—Mr. Augustus Fendler, who, under the direction of Dr. Engelmann, went out to Santa Fe in the autumn of 1846 for the purpose of exploring the botany of that region, has now returned to St. Louis with his rich collections, which will be immediately distributed to purchasers. Owing to the great difficulty and danger of herborizing in that region, only a very limited number of sets were prepared. He offers about 10 sets of 400 to 500 species, 10 more of about 300 species, and 20 of about 200 species. The specimens are well made, in good condition, and mostly very fine and complete. A printed account of them, with descriptions of the new species, by Prof. Gray and Dr. Engelmann, will soon appear, a copy of which will be sent to each subscriber. The price is fixed at $10 per hundred, exclusive of transportation from St. Louis to New York or Boston. As all the sets not taken up here, will be sent abroad at once, those who desire them should make early application (post paid) to Dr. George Engelmann, St. Louis, or to Dr. A. Gray, at Cambridge, Massachusetts. A. G.

2. *Materials towards a History of the Coleoptera Longicornia of the United States;* by S. S. Haldeman, Philadelphia, 1847, 66 pp. 4to, (from the Transactions of the American Philosophical Society, vol. x.)—This valuable memoir, besides giving a detailed catalogue of known species with full references, contains also descriptions of many new species. The number as yet found in the United States is stated at 270, while in France 180 have been found, and in England 64. Mr. Haldeman mentions that the following five species, Criocephalus rusticus, Hylotrupes baiulus, Phymatodes variabilis, Clytus gazella, Callidium sanguineum, Monohammus sutor, Pachyta sexmaculata, appear to be identical with European species, adding that "as rigid comparisons have not usually been made, and as our own presumed nondescripts could not readily be compared with European analogues, it will probably be found that a number of the latter have been redescribed here, under new names, as in the case of Clytus gazella." "The North American forms of the Longicornia seem to have a nearer relation to those of Europe than to those of South America; the same genera being mostly found in both regions, to which some of the northern forms are almost entirely confined, as Oberea, Rhagium, Pachyta, Strangalia and Leptura. The Prionida are most fully represented in the western hemisphere; the Genera Elephadion, Desmocerus,

Tetraopes, Dorcaschema, and others, are strictly North American forms, while the extensive European apterous genus Dorcadion, is perhaps entirely unknown here. Among the genera common to North and South America may be mentioned Mallodon, Callichroma, Eburia, Amniscus, Oncideus, Hippopsis, Amphionycha and Distenia."

3. *Eggs of the Moa, the extinct gigantic bird of New Zealand;* (extract of a letter to the senior editor from Dr. Mantell, dated London, Nov. 2, 1847.)—"My son Walter Mantell, (a resident of New Zealand,) has made me a huge collection of Moa's bones which are on their way to me. He has discovered among the bones, fragments of the egg shells which he sent to me in a letter. They are highly interesting. They differ in their marking from any known, but most nearly approach the eggs of the South American ostrich. The surface is covered with fine interrupted linear markings, - - - - - not depressions or punctures . . . . . like the ostrich. They are relatively thinner than the ostrich's eggs and from their very slight convexity must have belonged to eggs of great size. They are of a cream color, and the edges of many of the fragments are rounded from alluvial attrition. They have a very recent appearance, and the birds, if extinct, cannot have long been so."

In the October number of the Annals and Magazine of Natural History, it is stated that the portions in Dr. Mantell's possession belong to several eggs and apparently to different species of the Moa; the linear markings are variously disposed in different specimens. Mr. Walter Mantell's collection of bones amounts from seven hundred to eight hundred of different parts of the skeleton; among which are specimens of the mandibles which have not been previously obtained. These bones will doubtless furnish some interesting additions to our knowledge of the remarkable birds of the ostrich tribe which once trod the soil of New Zealand.

IV. Astronomy.

1. *Brorsen's Comet, found July* 20.—Mr. Brorsen at Altona discovered a faint telescopic comet on the 20th July, 1847, in R. A. $1^h\ 49^m{\cdot}7$ and N. decl. 26° 7′. The following elliptic elements of this body from observations of July 21, and Aug. 1 and 11, were published by M. Faye, of Paris, in the *Comptes Rendus* of Aug. 23, 1847.

Perihelion passage, 1847, Sept.	9·16128	
Long. of perihelion,	78° 23′ 52″·1	m. eqx.
" " asc. node,	310 14 49 ·3	Jan. 1, 1847.
Inclination,	19 19 7 ·8	
Excentricity,	0·9961247	
Perihelion dist.,	0·4939490	
Motion,	direct.	

This comet is the same as that discovered, Aug. 11, 1847, by M. Schweizer of Moscow.

2. *Miss Mitchell's Comet, found Oct.* 1.—The comet discovered on the night of Oct. 1, 1847, by Miss Maria Mitchell at Nantucket, Mass., was detected on the 3d of that month by the astronomers of the Observatory at Rome,—on the 7th by Rev. W. R. Dawes at Cranbrook, Eng.,—on the 8th by M. Colla, at Parma,—and on the 11th by Madam Rümker, at Hamburg. Miss Mitchell is therefore the earliest observer of this body, and is moreover the first American entitled to the honor of the original discovery of a comet. A communication on the subject will be found at p. 83 of this number.

3. *Schweizer's Comet, found Aug.* 31, (Astr. Nach., No. 612.)—M. Schweizer, observer at Moscow, discovered on the evening of Aug. 31, 1847, a faint telescopic comet not far from ε *Cassiopeiæ*, its position being about R. A. 30° and N. decl. 65½°. The following parabolic elements were computed by Dr. Petersen, from the Altona observations of Sept. 11, 13, 15.

Perihelion passage, (Berl. m. t.)	1847, Aug. 8·18973.	
Long. of perihelion, . .	22° 10′ 24″·8	App. eqx.
" " asc. node, . .	75 58 24 ·7	Sept. 13.
Inclination, ...	32 41 24 ·5	
Log. perihelion dist., . .	0·169672	
Motion, ...	direct.	

4. *Elements of the Planet Iris.*—M. Yvon Villarceau communicated to the French Acad. of Sciences, Oct. 18, the following corrected elements of the planet Iris, which was discovered by Mr. Hind, Aug. 13, 1847.* The elements founded on the earlier observations were quite erroneous, in consequence of the unfavorable position of the planet with respect to the earth.

Mean long. 1847, Aug. 13·0. Par. m. t.,	334° 12′ 35″·3	m. eqx. Aug. 13.
Long. of perihelion, . . .	41 56 20 ·2	
" " asc. node, . . .	259 53 14 ·0	
Inclination, ...	5 28 51 ·4	
Log. semi-axis major, ...	0·3758769	
Excentricity, ...	0·2268410	
Period in sidereal years, . . .	3·663	

5. *The New Planet Flora.*—Mr. J. R. Hind of Mr. Bishop's Observatory, London, discovered on the 18th October, 1847, another planet belonging to the group between Mars and Jupiter. It was not far from the star 15 *Orionis*, and appeared like a star of the ninth magnitude, with a bluish light. By measures from a star Bessel v, 48, Mr. Hind obtained the following positions of the new planet.

		R. A.	N. decl.
1847. Oct. 18,	11h 40m 4s Gr. m. t.,	5h 3m 40s·11	14° 3′ 35″·4
	15 4 10	41 ·51	26 ·2
	52 27	41 ·97	25 ·3

6. *Satellite of the Planet Neptune.*—Mr. Lassell, of Liverpool, in a letter dated Sept. 20, 1847, to the Editor of the *London Times*, states that he finds the period of the satellite of Neptune to be 5 days, 20 hours, 50 minutes, 45 seconds,—which he thinks cannot be more than a few minutes in error. The projected orbit is a narrow ellipse, with

* See this Journal, ii ser., vol. iv, p. 425.

an axis inclined about 28° to the Ecliptic, and with its semi-axis subtending about 18″, so that the satellite is about 250,000 miles from the planet. It is much brighter in the preceding than in the following half of its path. The orbit which it appears to describe has a minor axis differing little from the diameter of the planet. The periodic time assigned by Mr. L. accounts for all the configurations of the planet and satellite, noticed by him since his discovery. The observations in 1847, from Aug. 31 to Sept. 6, are quite conclusive as to the existence of the satellite. Mr. L.'s observations have all been made with a Newtonian reflector, constructed by himself, of 24 inches diameter and 242 inches focal distance, using magnifying powers of 205 and 370.

This satellite has also been seen by the aid of the Grand Refractor, at Cambridge, Mass., and Mr. Bond has published his observations thereon of Oct. 25, 27, 28, 1847. In the course of these observations, the existence of another satellite fainter and more distant, was strongly suspected.

In a letter dated Oct. 26, 1847, to the Editor of the Boston Courier, Prof. Peirce remarks, "the mass of Neptune corresponding to Mr. Lassell's result, is equal to that of Uranus, so that with this mass, *one half* that of Leverrier and Adams, it cannot account for more than *forty* of the *one hundred and eighty* seconds of the unexplained irregularities in the motion of Uranus."

In regard to the *ring*, nothing absolutely certain is yet determined, but Mr. Lassell has no doubt of its existence.

V. Miscellaneous Intelligence.

1. *Crystallography: Memorandum;* by J. H. Alexander, (in a letter to the senior editor, dated Baltimore, Dec. 7, 1847.)—You may perhaps recollect my mention to you of some ideas which had presented themselves in the course of researches I was making into the characteristics of crude iron. I have, as opportunity served, pursued those researches, and believe that I have arrived among other things at a law of great importance in physics, and whose application will impress upon the science it particularly concerns—that of crystallography—an entirely new aspect. I shall, in due time, exemplify and publish this law, but as circumstances may for a while continue to retard this design, I think it will not be amiss, in advance of the development and in order to settle or rather prevent any future question of priority, to take date as it were, by a direct announcement of the principles and results already arrived at. Such an announcement I prefer to make in the manner habitual during what may be called the transition period of the science in the seventeenth century;—I mean, by an anagram. The manifest, various advantages of this resort outweigh with me the otherwise too serious objections to it on the score of singularity.

I send you therefore the following anagram expressive of the fundamental principle of the law and of its scope, which I should like to have published in the January No. of the Journal, with such portions of this letter as you may consider appropriate.

11A+2B+12C+ 3D+16E+7F+ 3G+ 5H+13I+
8L+ 6M+11N+14O+ P+12R+10S+
14T+ 2U+ W+ X+ 3Y.

2. *Tribute to American Geologists*, (translated from *Leçons de Geologie Pratique, par M. L. Elie de Beaumont*;* by C. T. Jackson.)—The following passages I translate from the recent work of M. L. Elie de Beaumont, the most eminent of French geologists. It is perhaps too flattering an account of our labors, which I regret to say are too incomplete to deserve so high an encomium, but still I am desirous to lay it before my countrymen, to show them how highly their labors are appreciated in France, that it may serve to stimulate us to renewed exertions, while it may also turn our attention more to France, and cause us to unite more cordially than ever with our ancient allies and most friendly associates.

"In truth we are never more penetrated with the natural connection of ideas relative to geology, than while following in our minds the geologists in countries where every thing is to be done, in countries which have not been submitted to any observations. They are obliged, as we perceive, to occupy themselves with a crowd of objects that are intimately connected, such as the determination of latitudes and longitudes, the measurement of heights, the determination of the elements of climate, the picturesque nature of the country, its topography, and its principal productions. It is this which M. Humboldt accomplished when he traversed the different regions of the New World, and his course has served as an example to other geologists, who have followed the science in its most elevated point of view.

"This is what we see in the very numerous and minute explorations which are made in the United States of America. Geological researches are carried forward there with great activity. A great number of geologists can be enumerated who are making careful and continuous observations. As they consider the subject in an economical point of view, and those who direct public affairs feel the advantages of science, and of geology in particular, they have undertaken geological maps of the different states,—of North and South Carolina, of Massachusetts, of Connecticut, of New Hampshire, of Maine, of Rhode Island, of New York, of Pennsylvania, of Maryland, of New Jersey, of Delaware, of Virginia, of Georgia, of Ohio, of Tennessee, of Kentucky, of Indiana, of Michigan, &c. Each of these states has its geological map made or commenced.

"In America their undertakings have a character of generality, at once interesting and instructive. American engineers have to make a complete exploration of the nature of the country, and the manner in which they proceed gives an idea of the relations of geology to all the sciences which surround it, and to which it serves as a common bond. We see in the steps which they are required to follow, how all these various parts hold together much better than in Europe, where most of the countries have already been more or less explored, and the labor has thus been divided in advance. They have not, as in Europe, topographical maps published beforehand: the geologists have to

* Leçons de Geologie Pratique professées au College de France pendant l'année scolaire 1843, 1844; par L. Elie de Beaumont, Mem. del Acad. Royale des Science de l'Institut de France, Ingenieur en chef des mines, Profr. au College Royale de France, Officier de la Legion d'Honneur, &c. &c. T. premiere. Paris, 1845.

make or complete their geographical and physical maps. They have to measure heights—they have to determine the composition of the soil—and they are charged also with the exploration of matters of public utility, such as result from the nature of the soil, relation to agriculture, the valuation of uncleared lands which the State may have for sale, the indications of all the quarries and all the mines that may be found in the district.

"These are the very important functions which the state geologists, as they are called, have to perform. True enlighteners of science and of industry, they have a much greater mission to fulfill than that of the engineers of mines in France, even more than those who are charged at the same time with the execution of geological maps, and the superintendence of mines and furnaces. In Europe, geologists have rarely to give indications such as are required of the American geologist, because the principal quarries and mines have been for a long time known.

"In America, where civilization advances daily into countries which had not before been cleared, the geologists have to pursue the science in all its several parts, because no part of the work has been done in advance; and they have to proceed in a methodical manner. When they have pointed out a mine, they have even to make known the method of working it.

"Their mission extends also to the examination of the productions of the soil, to the description of the Flora and Fauna of the country, so that the labors of which the geological maps are the occasion, result in a complete Encyclopedic investigation of each state."—*Lecture 2d, December 12th, 1843, pages 48, 49, and 50.*

3. *Circular on a Statue to Geoffroy St. Hilaire*, addressed to Dr. Charles T. Jackson, President of the Association of American Geologists andNaturalists, (translated for the Amer. Jour. of Science, by C. T. Jackson.)—With the desire of responding to a wish which has been strongly manifested in France and throughout the rest of Europe, it has been decided that a statue in bronze should be erected by subscription to the memory of one of the greatest naturalists of the nineteenth century: to the memory of M. Etienne Geoffroy St. Hilaire. The monument, which will be the work of the celebrated statuary David, will occupy a most happily selected spot. It will tower majestically in the picturesque village of Etampes (the native town of M. Geoffroy) and near the railroad so much traversed between Paris and Orleans.

At their first meetings, the administrative and municipal authorities of Etampes, the compatriots of M. Geoffroy, the members of the Institute, found themselves placed at the head of the subscription, and they remembered the large, liberal, and eminently honorable aid, which the scientific societies of America hastened to give to the commissioner for the monuments to Cuvier.—They would have believed they were doing injustice to their societies, which are so renowned and so glorious to America, if they had admitted for a moment, that an enterprise of this kind would not awaken the same sentiments.

Every thing on the other hand authorizes them to think, that the illustrious author of the *Philosophy of Anatomy*, who by his genius conceived and enlightened the grand principle of unity in structure, an

idea around which the labors of the zoologist are daily grouping, is not less appreciated in the new world than in the old.

Every thing tends to satisfy them that the American savants, so numerous, active and fruitful, and so ardently devoted to the progress of human knowledge, would accord to the memory of M. Geoffroy their testimony of sympathy which would excite in France the most lively satisfaction and profound gratitude.

Such, sir, are the sentiments which have decided the subscribers to address you the prospectus annexed, and to ask you to communicate it to the Association in which you preside.

Permit us to add our knowledge and gratitude in advance and our respectful sentiments.

(Signed.) *Duméril, Arago, Dumas, Serres, L. Elie de Beaumont, Jomard, Reynaud, Roche.*

Paris, April 30, 1847.

4. *A Thanksgiving Present* to Prof. Agassiz*, (New York paper.)—Among the many ceremonies of Thanksgiving day, we have heard of none that was more agreeable than a compliment paid to Professor Agassiz, by the students of the New York College of Physicians, before whom the Professor has recently been delivering a course of scientific lectures. The compliment consisted in the fact that the students presented the distinguished lecturer with a silver box, which contained the sum of $250 in half-eagles, to which was added a free passage ticket to Charleston, where the Professor is engaged to deliver a new series of lectures. The ceremony of presentation took place at the College in Crosby street, on Thursday morning, and the speech with which the gift of affection and esteem was received, was very interesting. The Professor is to take his departure for the south in the steamer of Saturday.

M. Agassiz since his arrival in this country has been treated by our scientific and literary citizens with marked respect, for every body admires the man and the scholar. It may not be known to our readers that the Professor's favorite pursuit is that department of science having particular reference to the finny tribes. Since his arrival among us, he has made a number of new discoveries with regard to fish, which are said to be of very great importance. And as an evidence of his indefatigability, it might be mentioned that for some weeks past he has been an early and a constant visitor to our city markets, where he has kept a number of fish mongers in his pay, from whom he has obtained a variety of rare curiosities.—Even our butchers and market women, have been familiar with his mild and manly countenance, and always seemed to take particular pains to salute him with a polite bow. May health and prosperity attend him through his southern tour.

5. *Adulterations in Medicines.*—From a printed circular by the Trustees of the College of Pharmacy, New York, we cite the following facts with regard to the adulterations in medicines used in the United States.—Bromid of potassium is imported and sold for the iodid of potassium, some parcels being mixtures and others entirely bromid. The iodid is also adulterated frequently in large proportion with other salts of an entirely different character.

* This present was made in addition to the regular emoluments of the course.

Blue pill is imported containing a per-centage of mercury from ten down to seven and a half, mixed with blue clay and prussian blue, to give the proper density and color. Two importations of this kind from the manufactory of William Bailey, of Wolverhampton, have been publicly exposed by this College in the newspapers, the first in the year 1845, and the second and worst lot during the present month. Its composition according to the analysis of our Prof. Reid, is,

Mercury,	7·5
Earthy clay,	27·0
Prussian blue used in coloring,	1·5
Sand in combination with the clay,	2·0
Soluble saccharine matters,	34·0
Insoluble organic matters,	12·0
Water,	16·0
	100·0

An account of the former, with the correspondence between our late President Adamson and Mr. Bailey, was also published in the American Journal of Pharmacy, vol. xi, (new series,) p. 148. The latter appears in the New York Journal of Medicine for September.

Very large quantities of rhubarb, much decayed, the better parts of which are dark colored, with scarcely any taste or smell, having probably been exhausted to make extract, come from England, invoiced there from 1½ to 3 pence sterling per lb. It is intended and used for powdering, color being given to it by turmeric, &c.

The article called oxyd of zinc on the English labels, is generally carbonate of zinc, being imported at a price which precludes the possibility of honest preparation.

All that is received under the name of precipitated sulphur, (or "lac sulphur," as the merchants commonly term it,) except when it is expressly ordered, from an honorable manufacturer, contains from 80 to 95 per cent. of sulphate of lime.

Opium is often invoiced at one-third the value of good quality, and is found upon examination not to be worth even that. The same may be said of scammony.

Most of the foreign extracts are not what they profess to be, and cannot be relied upon in the treatment of disease.

The salts of quinine, morphine, and all the more costly chemicals, are greatly adulterated.

We are informed by the agent of an English manufacturer of chemicals, extracts, and many other preparations used in medicine, that it is a regular and systematic business, carried on by his principal and others in his line, to make articles for the American market of different qualities, one for the Atlantic cities, and another, very much inferior, "for the West," meaning thereby our Western States. He gives us, for instance, the following quotations: "compound extract of colocynth, 9*s.* 6*d.*; do. for the West, 5*s.*"—the latter, as we are allowed to infer, containing no scammony at all, only the poorest sort of aloes, and but little, if any, colocynth, or extract from it. "Blue pill, 3*s.* 9*d.*; for the West, 1*s.* 8*d.*"

Is it wonderful that such uncommon doses as we hear of, are taken, and indeed required at the West, and that disappointment is every where experienced by physicians in the action of medicines? And these examples are but few out of many that might be given.

This circular has been addressd as a memorial to the Legislature of New York, praying that a law may be enacted, declaring that all imported articles intended for medical use, which may appear to the proper Custom House Officer to be spurious, counterfeit, or adulterated, shall be subject to competent inspection, and if found to be of base character, confiscated and destroyed.

6. *On the Ruins of Nineveh;* by AZARIAH SMITH, (addressed in a letter to Prof. B. Silliman, Jr.)—It was my rare fortune to travel two days, a few weeks since, in company with Mr. Layard, who was then on his way from Mosul to England. He is the English gentleman, who, aided by a scientific society of Great Britain, has been employed for the last year or two in making excavations about the ruins of Nineveh. His main work has been done at Nimrood, at or near the junction of the Zab and the Tigris, some twenty miles south of the excavations made by Mons. Botta at Khorsabad. From inscriptions partially deciphered, it would appear that one of the three palaces disentombed at Nimrood, and that at Khorsabad were built by father and son, or other near relatives; and from other inscriptions disentombed by Mr. Layard from the mound of Zoyumjonk, (the mound of long repute directly opposite the city of Mosul,) it would appear that that also sustains a similar relation to the others. From this fact, the view which I presented in the article in your Journal, that Nineveh was latterly made up of several collections of houses interspersed with gardens, receives additional support, and all doubt is now removed from those passages of sacred and profane history, which make it an exceeding great city of three days journey. From opposite Mosul to the mouth of the Zab and interior from the river as far east as Khorsabad, will give the territory required by such a description. Among other most interesting stones sculptured and carved sent to England from the disentombed palaces of Nimrood, there is an obelisk of considerable size, containing as appears from the partially deciphered inscription, a chronological list of the kings of Assyria, beginning with Ninus,—and it would seem that it agrees with authoritative Egyptian chronology.

But I have no space to detail farther. The time is doubtless near, when by the aid of Major Rawlison of Bagdad, the world will have all these inscriptions translated out before them in detail, and in the mean time Mr. Layard will furnish his society with the means to publish accurate copies of the inscriptions and drawings and plans of all the figures and rooms which have been disinterred. He goes to England immediately for this purpose.

OBITUARY.

7. *Death of* ALEXANDER BRONGNIART.—This distinguished man has finished his mortal career, and his obsequies were performed at Paris, Oct. 9, 1847.

We have in progress a translation of a part of a discourse upon his life and character, pronounced by Mr. Elie de Beaumont, but its length

precludes its appearance in our present number, and we reserve it for the next. In our present brief notice we shall have reference, chiefly, to our personal knowledge of Mr. Brongniart.

He early favored the senior editor of this Journal with a collection of materials, such as were employed by him in the manufacture of porcelain at the royal establishment at Sèvres near Paris, of which he was many years and at his death the Superintendent. It was accompanied by a catalogue, in detail, descriptive not only of the specimens, but of the processes for preparing the materials, modelling the vessels, baking them in biscuit, glazing, ornamenting and enamelling; and even the saggars or earthen cases in which the pieces of porcelain were separately baked, were sent out with the indurated cement by which they were united. One of the most interesting things in the collection, was a series of porcelain tablets about three inches by two, containing samples of the principal colors used in ornamenting porcelain; being of equal size, they are now framed under glass and form a beautiful picture. They appear to have been presented to the immediate superintendent for his inspection, as remarks and corrections are indorsed upon them.

We were indebted also to Mr. Brongniart for copies of the two editions of his great work, splendidly illustrated, on the mineral geography of Paris and its environs, being the result of the examination made by the joint labors of Cuvier and Brongniart upon the geology and palæontology of that interesting region, which resulted also in the production of Cuvier's magnificent account of the fossil bones. Mr. Brongniart also sent out a collection of minerals and fossils illustrative of the Paris basin and of other instructive fields. From time to time, also, we received from him his different memoirs on portions of Scandinavia, Italy, &c., in which he had made important geological observations.

Full and able letters accompanied his donations, explanatory of their object; they were conceived in the best spirit of liberality and kindness, as well as of science and intelligence. Through his influence also, we received occasional communications from his distinguished son, Mr. Adolphe Brongniart, particularly portions of his great work upon fossil vegetables. We were happy to have it in our power to aid in a small degree in this great research into the ancient vegetation of our planet, by sending out numerous and well characterized specimens of the impressions of plants upon the coal rocks of the valley of Wyoming and other anthracite regions in Pennsylvania, the bituminous coal field of Zanesville in Ohio, and the anthracite beds of Rhode Island; which we were happy to learn gave great satisfaction to both the father and son,—a satisfaction still farther augmented by the elaborate exhibition of the coal vegetation of Ohio, Virginia and the West generally, in the able account of them by Dr. S. P. Hildreth, in the American Journal of Science and Arts, vol. xxix. From these and other similar sources of information, the identity of the coal regions of North America with those of Europe was fully established. The American Journal, two copies, has been constantly forwarded to the Messrs. Brongniart as a small mark of respect, and as a return for their fine works.

An early treatise of the elder Brongniart was so serviceable in our courses of instruction, that it deserves a mention on this occasion. Some thirty-five years ago, we were struggling both to obtain and to commu-

nicate information in the science of mineralogy, then in its infancy in this country. We were however thrown almost into despair by the unsuccessful effort to describe minerals intelligibly to our pupils, by the minute and dry technicalities of the Wernerian language—useful and satisfactory as they are to adepts. At this time we obtained a copy of Mr. Alexander Brongniart's Mineralogy, being the substance of his lectures as given in Paris. In this admirable work we found just what we wanted. The classification and arrangement were excellent, the descriptions perspicuous and discriminating; the most important and distinctive characters were made prominent, and those that were minute and unimportant were omitted. It was a common off-hand mode of describing, which placed the picture in full outline before the eye without too elaborate a filling up. The uses of the minerals were also indicated in a striking manner, and with this work literally in hand as a text-book, and cited from topic to topic, and occasionally read aloud into English, there was no longer any serious difficulty in making mineralogy interesting and instructive to the pupils. It is very remarkable that this work, of unrivalled excellence, was never published in more than one edition, that of 1807—forty years before the death of the author.

It is equally remarkable that the best work ever published in the English language upon the subjects of which it treats, namely, the Dictionary of Chemistry, Mineralogy and Geology, and the connected Arts, in two full volumes quarto, by the Aikins, in 1809, has also been confined to a single edition, and is now almost unknown to the younger class of students.

In mineralogy we are no longer deficient in excellent American works; that of Prof. Cleaveland in two volumes and in two editions has too long slumbered, having been many years out of print;—but other works have come to our aid, which meet the wants of the country, although a smaller work as a manual for young students is still a desideratum. The mention of Mr. Brongniart's admirable work has led us into this digression from which we return. Our latest communications from Mr. Brongniart were sometime since respecting his unique and original effort to form a museum of the productions of the plastic art of all nations and ages. We did not withhold our efforts as invited by him on this subject, although they were less successful than we could have wished, as our then known* aboriginal productions in this line were—excepting Mexico—few and humble, and the manufacture of pottery and porcelain was only beginning to become conspicuous in the United States.

Excellent porcelain was however produced at Philadelphia, hardly inferior in the fineness of the material and in the beauty of modelling to that of Sèvres—but this country was not as yet willing to pay for the highest order of talent and skill in the ornamental part of the coloring and figuring.

From Mr. Brongniart's beautiful work on the Ceramic Arts—the result of the effort mentioned above, we learn that he has been success-

* The more recent researches of Messrs. Squier and Davis have brought to light many beautiful things from the mounds or barrows in the Western States.

ful; and the museum which he has collected must form an interesting and instructive addition to the numerous attractions of Paris, in science and the arts.

In this brief and limited notice of a great and excellent man, we have been necessarily led into some personal details. To the few who —on grounds of propriety—object to every thing of this nature, we have nothing to say; being of opinion that when the work of an eminent and successful benefactor of his race is finished and he is withdrawn from our world, it is only a simple act of justice to his memory to relate what we know of his good and useful deeds and of their bearing on the common good of mankind.

In taking our leave of an early friend and benefactor, we are again reminded how fast the names are being stricken from the roll of those who led us onward in our course—cheering and directing us by the brilliant lights they have held forth; and how fast too, our fellow laborers in the common cause are dropping from the ranks. But such considerations, plaintive as they are, should only stimulate us to work on to the end, that our good deeds—if happily we have performed any—may live when we are gone. B. S., Senior.

Dec. 15, 1847.

8. James Kent and Timothy Pitkin.

Died in New York on the 13th of December, James Kent, late Chancellor of the State of New York, aged 85; and in New Haven on the 18th of December, Timothy Pitkin, Esq., formerly a distinguished member of the Congress of the United States, aged 82. The studies of these eminent men were not in the field of natural science, but of jurisprudence, national law, statistics and history.

This Journal is not the appropriate place for the full display of their merits, but we are not willing to let them pass away, without being named in the calendar of departed friends; friends of universal knowledge; friends of their country and of mankind, and warm personal friends of the writer of this brief notice.

Chancellor Kent was a man of great versatility of talent and acquirement, and of inextinguishable enthusiasm, united to great vivacity of spirits, and untiring physical as well as mental activity; while his warm-hearted and simple manners and sparkling intelligence made him delightful to a wide circle of friends, and his kindness made him accessible to all. In his favorite science of jurisprudence and constitutional and national law, his studies were not confined to English and American legal learning, but embraced the codes and common law of other countries, especially of the most enlightened nations of continental Europe. His Commentaries, the production of his mature years, have already passed through numerous editions, and are stereotyped for posterity. Their merits and their fame place them side by side with the Commentaries of Blackstone, and their author's name revered and admired, will live to distant ages.

He survived to a good old age, but exempt from its decays. In the vigor of his intellect and cheered by hope, with no more physical infirmity than was necessary for the transition, he passed quietly out of life.

Mr. Pitkin sustained, during many years, a very responsible position in the House of Representatives of the United States; being regarded as a reliable authority in all questions connected with the history and policy of the government. He was a devoted student of all the learning connected with the institutions of his country; and such were his fidelity, his exactness, veracity and candor, and such his amenity and courtesy to all, that both the great parties of the nation listened with equal confidence to his statements, which were always anxiously expected on all great subjects of national policy. His work on American Statistics, and that on American History, place him among the standard authors of his country, and will transmit an honored name to future generations. Like Chancellor Kent, he was favored with fine physical health to a late period of life, and left it gently and almost without decay. Both of them were more than octogenarians, and they were scarcely divided in death—having died in the same week—and they have left behind them lovely examples of personal excellence in all the relations of life.

Here this imperfect notice might well stop, but feelings of gratitude as well as justice prompt to the mention of the fact, that in all our humble labors in the cause of knowledge, we have been for almost forty years, cheered onward and encouraged by the favor and approbation of these eminent men.

Chancellor Kent in 1810, took a young man by the hand, on his first appearance in popular works of travels, the scenes of which were found both abroad and at home; and the severer labors of science in both the elementary and journal form, and in public, oral and experimental efforts in subsequent years in various cities, were fostered by his kind approbation. Mr. Pitkin manifested similar views and feelings; and we trust we do not transgress the propriety of the occasion, while honoring the memories of men whom we have been proud to call our early and constant friends—friends of that class whose number is, year by year, diminishing as their names are transferred to the mournful obituary. SEN. ED.

New Haven, Dec. 23, 1847.

VI. BIBLIOGRAPHY.

1. *Tables of Logarithms of Numbers, and of Logarithmic Sines, Tangents and Secants to seven places of Decimals, together with other Tables of frequent use in the study of Mathematics and in practical calculations*; by ANTHONY D. STANLEY, A.M., Professor of Mathematics in Yale College. New Haven: Durrie & Peck. 1847. 8vo, pp. 394. Price $2 bound.

The logarithmic tables which have been published in this country, have been for the most part exceedingly meagre. They generally give the logarithms of numbers only to 10,000, and sines and tangents to single minutes. They extend only to five or six decimal places; or if they give seven places, since they do not furnish the proportional parts corresponding to the differences of the tabular numbers, very little advantage is gained in respect of precision, except at an unreasonable expense of time and labor. Among the tables which extend only to five places, those of Dr. Bowditch deserve the most honorable mention, as being neatly and accurately printed, and giving columns of proportional parts. They are a model for tables which only aim at that degree of precision which is required for purposes of navigation. The most extensive tables which have appeared in this country before the present year, are those of Mr. Hassler, which give the logarithms of numbers to 100,000 to seven places of decimals; also natural sines to every half minute of the quadrant, and logarithmic sines and tangents for every second of the first degree, for every ten seconds of the second and third degrees, and for every half minute of the remainder of the quadrant, accompanied with columns of differences for single seconds. This is a most valuable collection of tables; but unfortunately Mr. Hassler in attempting to reduce the volume to a "pocket form," has employed type so small as must soon prove ruinous to the eyes of any student. We may then assert without fear of contradiction, that before the present year, no tables have appeared in this country at all adapted to the wants of those who have occasion to engage in nice astronomic or geodesic computations. So notorious is this fact, that mathematicians have by common consent looked to foreign countries for the tables requisite in their computations. There was then a demand for such a book as Prof. Stanley proposed to furnish. Let us enquire how well he has acquitted himself of the task he has undertaken.

We are struck by the first glance at his book, with the fairness of the paper and the neatness of the type. The type is indeed somewhat

smaller than we would prefer; but for trigonometrical tables, where it is necessary to crowd sixty lines into a page, larger type would have been inconvenient.

In a volume of tables like the present, the grand problem is to compress the greatest amount of valuable matter into a given space, and so to arrange the materials as to furnish every possible facility to the computer. We shall be the better able to judge of the merits of Prof. Stanley's tables, by comparing them with those which have hitherto been most esteemed. We will then compare Stanley's table of logarithms of numbers with that of Hutton. The former extends to 100,000; the latter to 108,000. There is some convenience in the latter part of Hutton's table, particularly in computing compound interest for long periods of time, and in other problems of a like kind. But Prof. Stanley has given in half a page at the end of the volume, the numbers most useful for this purpose, and has thus effected a saving of sixteen pages of numbers. The arrangement of Stanley's table is very similar to that of Hutton, except that the former has sixty lines to a page, while the latter has but fifty. Prof. Stanley has a more effectual mode of indicating a change of the leading figures in the first column; a particular in which Hutton's tables were defective. But the most important improvement in Stanley's table is the use of *multiples* of the tabular difference instead of proportional parts. When it is required to find the logarithm of a number consisting of seven or eight figures, there is room for error in the seventh decimal place with the use of Hutton's table, from the neglect of the fractions which belong to the proportional parts. But with the multiples of Stanley's table, the correction due to the last figures of any natural number is immediately found with the same precision as can be obtained by a direct proportion. In this particular, therefore, we think Stanley's table must be allowed the preference over those of Hutton, Callet and Vega, all of which give proportional parts, but not multiples.

With respect to logarithmic sines and tangents, we think the superiority of Stanley's tables as compared with those of Hutton is still more decided. Hutton gives sines and tangents to every second of the first two degrees; but for the remainder of the quadrant he gives them only for each minute, with differences for 60″. In order then to find the correction for seconds, it is necessary to divide the tabular difference by 60, and multiply the quotient by the given number of seconds. This operation is so laborious that we presume no mathematician engaged in nice computations, ever long used Hutton's trigonometrical tables, provided he could find better ones. That a trigonometrical table extending to seven places of decimals, should give simply differences to 60″, when the differences for 100″ would occupy no more room, is unpardonable. On this account we long since discarded Hutton's table of sines and tangents. Prof. Stanley gives sines, tangents and secants for every 10″ for one-third of the quadrant, with differences to 1″. For the remaining two-thirds of the quadrant, he gives them only to single minutes, but with differences to 1″. There is also a supplemental table for the first two degrees, furnishing with entire precision even to the last decimal place, the sine, tangent, etc., by means of the logarithm of the arc expressed in seconds. Callet gives sines, etc., to every

second for the first five degrees, and for every 10″ throughout the quadrant; but this swells his table to 320 pages. It is believed that Prof. Stanley has furnished the most useful table of sines, etc., which has ever been given in the same space. Prof. Stanley next furnishes natural sines to five decimal places, with differences for each second. We wish he had added to this a table of natural tangents, for we consider them scarcely less important than sines, and they would have occupied but nine pages. Next in order we have thirty-four pages devoted to logarithms of numbers, and of sines and tangents to five places. This table is convenient in calculations, which do not demand the highest precision; as however this matter is all embodied in the larger tables, it might have been dispensed with better than any other portion of the volume.

Prof. Stanley has next given us a truly valuable traverse table. Hutton's table, which does not extend to fractions of a degree, does not answer the demands of common surveyors. The ordinary traverse tables which extend to quarters of a degree, with distances from 1 to 100, occupy ninety pages. Prof. Stanley's table occupies but six pages and yields *ten times* greater precision. The table of meridional parts extends to tenths of a mile, and at the end of the volume we have two pages filled with useful numbers of a miscellaneous kind. On the whole then, we think Prof. Stanley's volume of tables more valuable than any other work of nearly the same size with which we are acquainted, and we take pleasure in commending it to the notice of those who are engaged in computations requiring an unusual degree of precision.

2. *An American Dictionary of the English Language;* containing the whole vocabulary of the first edition in two volumes quarto; the entire corrections and improvements of the second edition in two volumes royal octavo; to which is prefixed an Introductory Dissertation on the Origin, History, and Connection of the Languages of Western Asia and Europe, with an Explanation of the Principles on which Languages are formed. By Noah Webster, LL.D., Member of the American Philosophical Society, &c. &c. General subjects of the work: I. Etymologies of English words, deduced from an examination and comparison of words of corresponding elements, in twenty languages of Asia and Europe. II. The true orthography of words as corrected by their etymologies. III. Pronunciation exhibited and made obvious by the division of words into syllables, by accentuation, by marking the sounds of the accented vowels when necessary, or by general rules. IV. Accurate and discriminating definitions, illustrated when doubtful or obscure by examples of their use, selected from respectable authors, or by familiar phrases of undisputed authority. Revised and enlarged by Chauncey A. Goodrich, Professor in Yale College; with Pronouncing Vocabularies of Scripture, Classical, and Geographical Names. Springfield, Mass. Published by George and Charles Merriam, corner of Main and State streets. 1848.

Considered only as a reprint of Dr. Webster's Dictionary—an elegant, accurate and *cheap* reprint, in a condensed and portable form—this book would have strong claims to public favor. But it is more than a mere reprint. To an important extent, it is the fruit of independent

labor and research; a new and studied contribution to English Lexicography. The original work of Dr. Webster is justly regarded as a stupendous monument of industry and erudition. Its superior merits have been recognized by those best qualified to judge, on both sides of the Atlantic. Yet no one man in the brief space of one man's life could give perfection to a work like this, embracing such a vast variety and multiplicity of subjects. And were it otherwise, could a perfect dictionary be secured, the incessant changes of a spoken idiom, shifting with the caprices of fashion as well as the advances of thought and knowledge, would very soon render it imperfect, and call for additions and alterations to make it correspond with the actual condition of the language. It was no injury, then, to Dr. Webster's fame, when the enterprising publishers of his Dictionary, intending to issue a stereotype edition in a single volume, resolved on subjecting the work to a thorough and complete revision. Professor Goodrich, the gentleman whom they fixed upon as Editor, is a member of Dr. Webster's family; and thus by circumstances as well as by abilities and learning, eminently qualified for the task committed to his hands. His name alone is a sufficient guaranty for the excellence of a work to which he has devoted nearly three laborious years.

In executing this revision, *art* and *science* in their various departments have been treated with particular care. It has been the aim of the Editor to secure at once completeness and correctness. He has made constant use not only of the general Encyclopædias, but also of the best special Lexicons and the ablest systematic treatises in each department. Those which have been principally relied on are mentioned in his Preface. But he has not been satisfied with this. Sensible that no man can be accurate on subjects which he has not studied specially and thoroughly, he has obtained the aid of numerous scientific gentlemen, each in his own field of labor. These also are named in his Preface, where he specifies the extent and nature of the services which they have severally rendered. Intent on profiting as far as possible by the information and experience of others, Professor Goodrich has made frequent inquiries of tradesmen and mechanics as well as professional gentlemen. In this way he has collected many valuable items, which were not to be learned from books; and has been enabled even to correct not a few mistakes which had crept into books, and through successive copying become extensively prevalent.

But the attention of the Editor has by no means been confined to technical and scientific terms. The wants of the general reader have been every where considered. Much has been done to illustrate the older English classics, Spenser, Bacon, Milton, &c., but especially Shakspeare, many of whose peculiar phrases and idioms will be found here very happily explained.

Many words of recent origin have likewise been inserted, words which growing out of the special conditions, circumstances, and wants of our own time, have assumed a permanent place in our literature, and may rightfully demand admission into a general dictionary.

Nor has the language of common life been overlooked. Colloquial expressions are ever and anon finding their way into books, to the great embarrassment of readers unacquainted with their meaning. Expres-

sions of this kind have been inserted and explained, accompanied by the proper designation of their character. Americanisms are marked as such, but in most instances traced back to their source in the mother country, where many of them, now unknown to literature, survive in the popular dialects of different counties. Anglicisms also, if we may call by such a name the vulgarisms of the English, are inserted in cases where their occurrence in literature renders desirable an explanation of their meaning. Many readers will be glad to find here those numerous terms peculiar to the English Universities, which have so often piqued at once and baffled their curiosity. As respects the present English use of words, the Editor has not depended wholly upon books, but has sought to secure the requisite thoroughness and accuracy by constant correspondence with literary friends in that country.

Dr. Webster's innovations in orthography have been made the subject of loud and often undistinguishing complaint. Professor Goodrich in some very interesting and judicious remarks divides them into two classes; one, in which Dr. Webster has only applied to a few exceptional cases, analogies which have already become extensively prevalent in the language; the other, in which without the guidance of any such general analogies he proposed a new mode of spelling, as better suited to the etymology. To the latter class, Dr. Webster himself had, in many instances, restored the established spelling: in the present edition it is restored to nearly all the rest. Most words on which usage differs are given here according to the different modes in use. Pronunciation also has been carefully attended to, with the view of making the work at once accurate and complete as a *Pronouncing Dictionary.*

The pronouncing tables of proper names appended to the work add not a little to its value. These are a table of Scriptural names prepared by Professor Porter; Walker's table of Greek and Latin proper names revised by Professor Thacher, with additions and corrections; and a table of modern geographical names, prepared under the superintendence of Professor Porter. Prefixed to the last are brief rules for the pronunciation of the principal European languages, which will contribute essentially to the convenience of the general reader.

The whole work is appropriately introduced by an interesting memoir of the eminent and indefatigable man, who left the AMERICAN DICTIONARY as a legacy to posterity, a monument of his own fame, and a lasting honor to his American fatherland.

3. *Palæontology of New York, Vol. I., containing descriptions of the Organic Remains of the Lower Division of the New York System, (equivalent of the Lower Silurian Rocks of Europe,)* by JAMES HALL, 338 pp. 4to, with plates 1 to 88, and 10 additional intercalated. Albany, N. Y., 1847.—It affords us great pleasure to announce the completion of this volume of the Palæontology of New York, by its able author, Mr. J. Hall. The field occupied by his labors is one of the most interesting in the world, as well for the multiplicity of forms as the number and extent of the strata included. The present volume embraces the lower part of the fossiliferous strata below the coal, or the lower Silurian. But 70 species of fossils from their strata were described when the work was begun; and this number has been increased in the course of Mr. Hall's researches to 381.

Although published under the auspices of a State, it is properly a work of the country; and while its merits will bring honor to the science of the land, the general bearing of its facts, the wide extension throughout North America of the strata investigated and of the fossils here brought to light, must give the work a high value among all interested in geological pursuits. Moreover Mr. Hall has labored to give completeness to the work as far as possible, by including species of other portions of the country. It must therefore be in the hands of all who would go forward intelligently in the investigation of American geology. There are many points interesting to science, which we intend to bring out in a future notice of the work.

The plates are in the main very beautifully executed. They exhibit an historical fact connected with the work—that lithography which was first adopted for the figures was afterwards rejected, from the unsatisfactory manner in which the plates were finished. A large part of the plates were reëngraved on steel, in which style the later engraving was done.

Much dissatisfaction has been felt by those interested in science, that the volumes of Reports of the New York State Survey were no where to be obtained by purchase. We are gratified to learn that two hundred copies of this volume are in the hands of Wiley & Putnam, of New York; and we would recommend to those who desire a copy to make early application.

4. *Manual of Magnetism, including Galvanism, Magnetism, Electro-Magnetism, Electro-Dynamics, Magneto-Electricity and Thermo-Electricity;* with 180 original illustrations; by DANIEL DAVIS, Jr.* Second edition. Boston: 1847.—In vol. xliii, of our first series, 1842, p. 381, we gave a decidedly favorable and commendatory notice of the work of which we are now happy to announce a second and improved edition. "Alterations and additions have been made to adapt it better to the purposes of a text-book for Colleges and High Schools, and also as a companion to the apparatus, as many new instruments have been contrived to illustrate these departments of science, and are now for the first time described." Mr. Davis is well known to us as an able man, both in the theory and practice of the sciences which he illustrates; and he has acknowledged the assistance derived from Mr. E. B. Horn, in new articles of apparatus which he has contrived or improved. The preparation of the present, as well as of the former edition, has been committed chiefly to Drs. John Bacon, Jr., and William F. Channing, names which justly command the confidence of the scientific public.

"The aim has been to give the book a practical rather than a theoretical character, and hypotheses have been sparingly introduced, and only when they are necessary for the explanation of the phenomena."

The present volume besides being a companion to the apparatus, is also a treatise, and may therefore be used as a text-book. We have cited from the preface the author's own views of his work, and can endorse them with our full confidence. For the purposes for which it has been prepared, we know of no work of the same extent which will

* Mathematical instrument maker, 428 Washington street.

prove equally valuable both to the teacher and pupil, and also to the private individual pursuing these sciences alone.

5. A. B. Gray, Esq.; *Report on the Mineral Lands of Lake Superior*, to the House of Representatives, June 17, 1846. 29th Congress, Document No. 211.—This Report is accompanied by a large detailed map of the Copper region, showing the tracts of country disposed of to proprietors, and the Report itself contains a list of conflicting claimants and of those whose titles are good. The mines hold out as they have promised and new veins are daily coming to light. From present appearances, the country south of Lake Superior, will become one of the most productive Copper regions in the world.

Downing's Fruits and Fruit Trees of America, new ed., 1 large vol. 8vo. *New York*, 1847. *Wiley & Putnam.*

C. Matteucci. Lectures on the Physical Phenomena of Living Beings. Translated, under the superintendence of J. Pereira. 12mo, 446 pp. *London*, 1847. Cloth 9*s.*

C. W. Pasley. On Limes, Cements, Mortars, &c. 2d ed. 8vo. *London*, 1847.

W. Whewell. Philosophy of the Inductive Sciences. New ed. *London*, 1847.

J. Debenham. New Theory of the Tides. 8vo, pp. 20. *London*, 1847.

Sir J. G. Dalyell. Rare and Remarkable Animals of Scotland, represented from Living Subjects. Vol. i, 4to, pp. 282, with 53 col'd plates. 1847. Sewed, £3 3*s.*

Sir J. F. W. Herschel. Results of Astronomical Observations in the years 1834 to 1838, at the Cape of Good Hope. Royal 4to, 452 pp., 18 pl. *London*, 1847. £4 4*s.*

E. Turner's Elements of Chemistry. 8th ed., by Liebig and Gregory. 8vo, pp. 1410. *London*, 1847. Cloth, 30*s.*

Robin. Des Vegétaux qui croissent sur l'homme et les animaux vivans. 8vo, 1847.

T. Craddock. The Chemistry of the Steam Engine. 8vo, 140 pp. *London*, 1847. Cloth 7*s.* 6*d.*

A. N. Hermannsen. Indicis Generum Malacozoorum Primordia, to the 6th fasc. inclusive. *Cassel*, 1847.

H. von Meyer. Zur Fauna der Vorwelt. 2 abthlg., roy fol. *Frankfort*, 1847.

H. Scheerer. Lerbuch der Metallurgie. Lief. 3, 4. *Braunschwig*, 1847.

Schreber's Naturgeschichte der Saugethiere, continued by J. A. Wagner. Parts 126 and 137, 7 plates each.

Siebold's Fauna Japonica, Aves, Fas. 3, 10 col. plates.

Biot. Traité élémentaire d'Astronomie Physique, vol. iv, 8vo, and Atlas. 1847.

G. Bischof. Lerbuch der Chemischen und Physikalischen Geologie, vol. i, complete. *Bonn*, 1847.

H. D. Richardson. The Pests of the Farm, with Instructions for their Extirpation. 12mo, 108 pp. *London*, 1847. Sewed 1*s.*

Sabine. Observations made at the Magnetical and Meteorological Observatory at St. Helena. Vol. i, roy. 4to, pp. 514. *London*, 1847. Cloth, 42*s.*

Odes Murs. Iconographie Ornithologique, 7th livr., 6 colored plates, in 4to, 8fr. each; in folio, 12fr. *Paris.*

H. Frey and R. Leuckart. Lehrbuch der wirbellosen Thiere, forming the 2d part of R. Wagner's Lehrbuch der Zootomie. 8vo. *Leipzig*, 1847. 3 *Thlr.* 18*sgr.*

Hawle and Corda. Prodrom einer Monographie der böhmischen Trilobiten. 4to, Prag, seven plates. 1847.

O. Heer. Die Insektenfauna der Tertiärgebilde von Œningen und Von Radoboj in Croatien. Vol. i, 4to, 8 plates. *Leipzig*, 1847.

Martius and Endlicher. Flora Brasiliensis, Fasc. 6, 7, 8, 9. Fol. 1847.

G. J Mulder. Chemische Untersuchungen. 8vo. 4*s.* 1847.

E. Poeppig. Nova genera ac species Plantarum quas in regno Chilensi, Peruviano, et in terra Amazonica annis 1827 ad 1832 legit, descripsit iconibusque illustravit. Tom. 3, fol., 100 colored plates. *Leipzig.* £7.

Proc. Boston Society of Natural History.—*April* 21, 1847.—p. 226. *Dr. A. A. Gould* mentioned that the American Moose, lately named C. lobatus by Prof.

Agassiz, was already named C. americanus by Richardson.—*June* 16, p. 237. Description of Shells of the Exploring Expedition (including seven Neritinæ and three Naticæ); *Dr. A. A. Gould.*—*July* 21, p. 242. Two new species of Alosa and one of Platessa; *Dr. Storer.*—*Aug.* 18, p. 245. On a new Chimpanzee, T. gorilla; *Dr. J. Wyman.*—p. 247. Observation on the American Torpedo; *Dr. Storer.*

Proc. Acad. Nat. Sciences of Philadelphia.—*Sept.* 28, 1847.—p. 262. On the Fossil Horse of America, with a plate; *J. Leidy.*—New species of Squalidæ from the Tertiary of South America; *R. W. Gibbs.*—*Oct.* 5, p. 272. Gypsum of Nova Scotia; *J. W. Dawson.*—*Oct.* 26, p. 278. A new Coluber of the United States (C. venustus), with a plate; *E. Hallowell.*—p. 280. Descriptions of Eocene Fossils, (nine species.) from Vicksburg, Miss.; *T. A. Conrad.*

Ann. and Mag. Nat. Hist. London.—*Oct.*, 1847, No. 133. On certain bones of the Plesiosaurus; *Prof. Owen.*—Fossil Botany and Zoology of Australia; *F. M'Coy.*—Additions to the Fauna of Ireland; *W. Thompson.*—New Brachiopoda; *T. Davidson.*—New Butterflies; *W. C. Hewitson.*—Remarks on some Cetoniadæ, with description of a new Australian species; *A. White.*—Classification of British Mollusca; *W. E. Leach.*—A new African Antelope; *J. E. Gray.*—Royal Society: *C. H. Jones* on the liver.—Zoological Society: *J. E. Gray* on the Finner Whales, with a new species; *J. Gould* on a new Apteryx, and a new arrangement of the Trochilidæ.

Nov., 1847, No. 134.—On the Habits of certain exotic Spiders; *A. Adams.*—Fossil Botany and Zoology of Australia; *F. M'Coy.*—On J. E. Gray's Catalogue of Mammalia and Birds presented by B. H. Hodgson to the British Museum; *E. Blyth.*—Ornithology of Tobago; *W. Jardine.*—On the White Chalk; *J. T. Smith.*—Clinteria Hoffmeistri, a new species of the Cetoniadæ from North India; *A. White.*—On Conjugation in the Diatomaceæ; *G. H. K. Thwaites.*—Zoological Society: *J. E. Gray* on the Porcupines of the Eastern Continent, with descriptions of new species.

Erichson's Archiv für Naturgeschichte, *Berlin*, ii Heft, 1847.—Conspectus of the Coleopterous Insects of Peru; *G. F. Erichson.*—Ornithological Notices; *J. Cabanis.*

Annales des Sciences Naturelles, *February*, 1847.—Embryogeny of Fishes; *Ph. de Philippi.*—Relations of the visceral arcs of the embryo in the two subdivisions of the Vertebrata; *E. Baudement.*—Organization of the Annelida; *E. Blanchard.*—On the Ustilagineæ, compared with the Uredineæ; *L. R.* and *C. H. Tulasne.*—On the parasitism of the roots of the Thesium linophyllum; *W. Mitten.*

March. On the Echinodermata; *Agassiz* and *Desor.*—Organization of the Galeoma; *H. Mittre.*—On the termination of the nerves, and structure of the ganglions; *R. Wagner.*—Anatomy and Physiology of the Naiads; *Dr. O. Schmidt.*—On the development of down and feathers; *Dr. Ch. Reclam.*—Growth of cellular membrane; *H. Mohl.*—Genus of Algæ, Derbesia; *A. J. J. Solier.*—African Fungi; *D. Montagne.*—New Plants of the Royal Botanical Garden of Berlin; *C. Kunth.*

April. On an organ in the Rays, resembling the electric; *C. Robin.*—Fecundation of the Orchideæ; *J. B. Amici.*—New plants; *E. Cosson.*—Rare plants about Cherbourg; *A. Lejolis.*—Species of Ficus in the Berlin Garden; *Kunth.*

June. On the inferior types of Annelida; *A. de Quatrefages.*—Metamorphosis of Mormolyce phyllodes; *Ver Huell.*—On the Bipinnaria asterigera; *Koren* and *Danielssen.*—Microscopic Examination of the shell of Crustacea; *Lavalle.*—Lymphatic system of reptiles; *M. Rusconi.*—Pulmonary apparatus of the Gymnarchus niloticus; *Prof. Munchner.*—On the Parasites on roots, referred to the Rhizantheæ; *W. Griffith.*—Formation of ligneous layers in dicotyledonous wood; *Prof. Unger.*—Flora of Columbia; *L. R. Tulasne.*—On the Diatomeæ; *G. H. K. Thwaites.*—Two neglected genera of Aublet; *H. Crüger.*—Notes on Catalogue of seeds of Garden at Pavia: *R. de Visiani.*

July. On the Echinodermata; *Agassiz* and *Desor.*—Anatomy of the Leeches and Lumbrici; *A. de Quatrefages.*—Circulation of Mollusca; *Milne Edwards.*—Parasitism of the Rhinanthaceæ; *J. Decaisne.*—French Cryptogamia; *J. B. H. J. Desmazières.*—On the Artocarpeæ; *A. Trécul.*

APPENDIX.

Planet Neptune; by SEARS C. WALKER, (in a letter to the editors, dated Washington, D. C., Dec. 21, 1847.)—I send you the elliptic elements of the planet Neptune, derived from a discussion of six hundred and eighty-nine observations, including the two ancient ones of Lalande.

Perihelion point,	$\pi =$	48° 21′ 2″·93 mean equinox Jan. 1st, 1847.
Ascending node,	$\Omega =$	130° 4′ 35″·03 " " " "
Inclination,	$i =$	1° 46′ 59″·54
Eccentricity,	$e =$	0·00857741
Mean daily siderial motion,	$\mu =$	21″·55448
Epoch, Jan. 1st, 1847,	$M =$	328° 31′ 56″·36 mean time Greenwich.
Period,	$T =$	$164\frac{6181}{10000}$ tropical years.

The perturbations of Neptune by all the other planets, for the dates of the observations, have been computed by Prof. Peirce, and have been used by me in preparing these elements. I subjoin the four normal places used as the basis of the computation, and their comparison with the ephemeris from these elements after applying to the elliptic places, Prof. Peirce's values for the perturbations. The places are referred to the mean equinox of January 1st, 1847, corrected for refraction and parallax, but not for planetary aberration.

Date, mean time Greenwich.		I. 1795, May 9d·45256	II. 1846, Nov. 7d·0	III. 1847, April 6d·0	IV. 1847, Aug. 22d·0
Obs. Geo. R. A.,	A	213° 39′ 34″·18	327° 49′ 50″·24	331° 49′ 45″·65	331° 19′ 13″·71
Obs. Geo. Dec.,	D	− 11° 34′ 36″·21	− 13° 34′ 21″·65	− 12° 9′ 17″·82	− 12° 24′ 7″·55
True elliptic long.,	v	215° 48′ 12″·73	327° 13′ 58″·37	328° 8′ 0″·93	328° 57′ 44″·75
Peirce's perturbations,	δv	+ 37″·60	+ 32″·10	+ 31″·29	+ 29″·49
Instantaneous value,	v'	215° 48′ 50″·33	327° 14′ 30″·47	328° 8′ 32″·22	328° 58′ 14″·24
True elliptic Radius Vector,	r	30·28772	29·99441	29·99042	29·98677
Peirce's perturbations,	δr	+ 0·01207	+ 0·01608	+ 0·01497	+ 0·01493
Instantaneous value,	r'	30·29979	30·01049	30·00539	30·00170
Computed Geo. R. A.,	A'	213° 39′ 32″·32	327° 49′ 53″·16	331° 49′ 44″·82	331° 19′ 13″·95
Correction of Ephemeris,	$=(A-A')$	+ 1″·9	− 2″·9	+ 0″·8	− 0″·2
Computed Geo. Dec.,	D'	− 11° 34′ 34″·89	− 13° 34′ 20″·42	− 12° 9′ 20″·47	− 12° 24′ 7″·56
Correction of Ephemeris,	$(D-D')$	− 1″·3	− 1″·2	+ 2″·6	+ 0″·0

The perturbations were computed on the hypothesis of the year of Neptune, being double that of Uranus. The result of this discussion of the elements, indicates that the year of Neptune falls short about three years and two-fifths of the double year of Uranus. When the slight modification of the perturbations is computed for the shorter period of Neptune, these elements will require a small correction only, in order to correspond exactly with observation.

Meteorological Phenomena.

1. *Rainbow at mid-day.*—On the 13th of December, at 1 o'clock, P. M., Professor Olmsted observed at Yale College an entire rainbow in the north, projected on a dark cloud, the sun meanwhile shining brightly through a fine misty rain.

2. *Rainbow in the Zenith.*—In the month of August or September last, from 10 to 11 o'clock, A. M., Rev. Isaac Bird of Hartford saw a complete circular rainbow in the zenith. The atmosphere was a little hazy, but no where so thick as materially to obscure the body of the sun. No rain fell. The circle was smaller than solar and lunar halos. The colors of the rainbow were distinct.

3. *Aurora Borealis in the morning.*—A brilliant aurora, accompanied by numerous large streamers and auroral waves, was seen at this place (New Haven) before daylight on the morning of Dec. 20th.

Morse's Electric Telegraph.

On Monday, Dec. 20, telegraphic communication was opened with St. Louis. The Atlantic Ocean at Boston or New York, is now in constant and almost instant converse with the Mississippi—a distance exceeding 1000 miles. (See pp. 68, 69.)